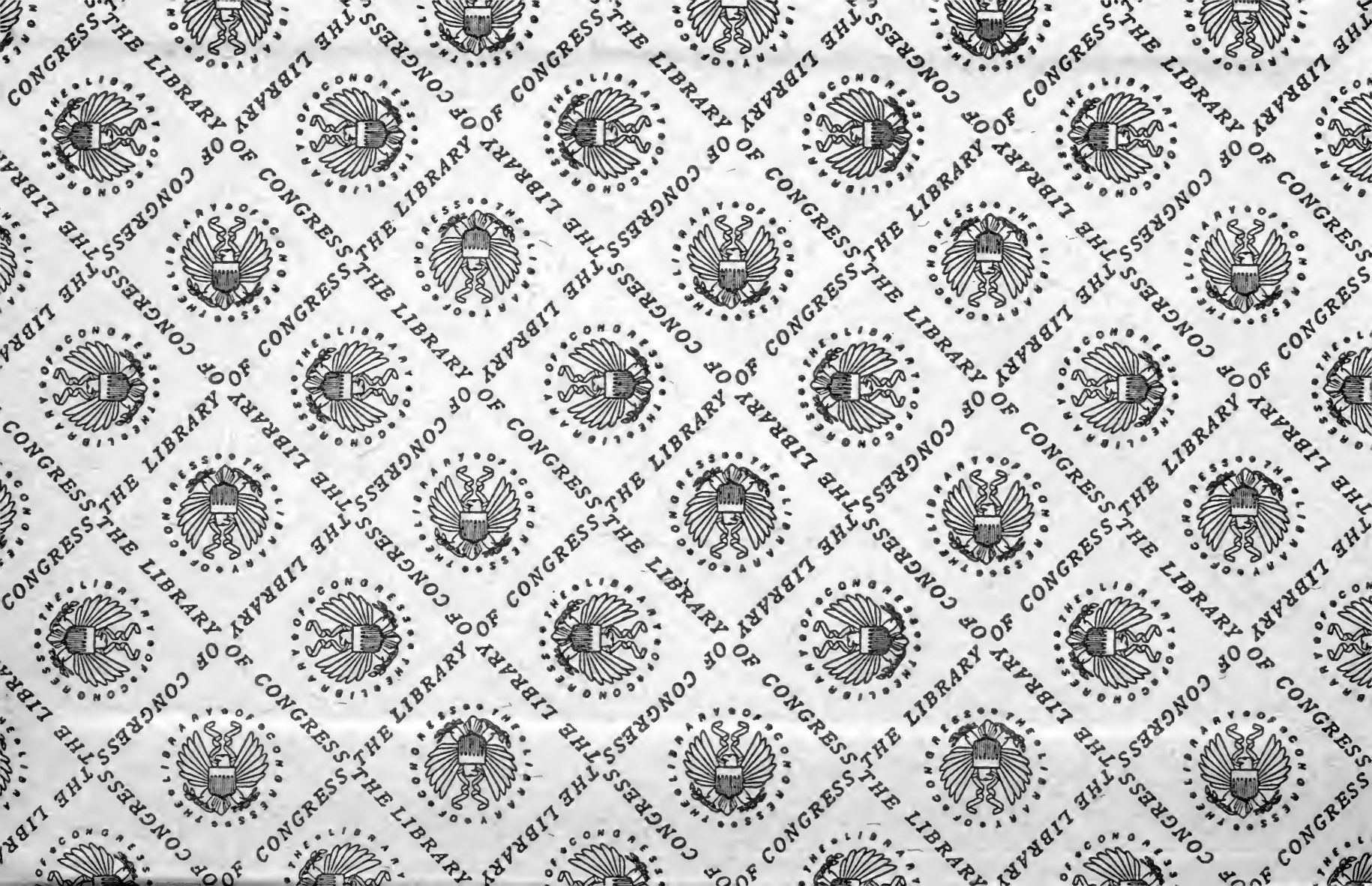
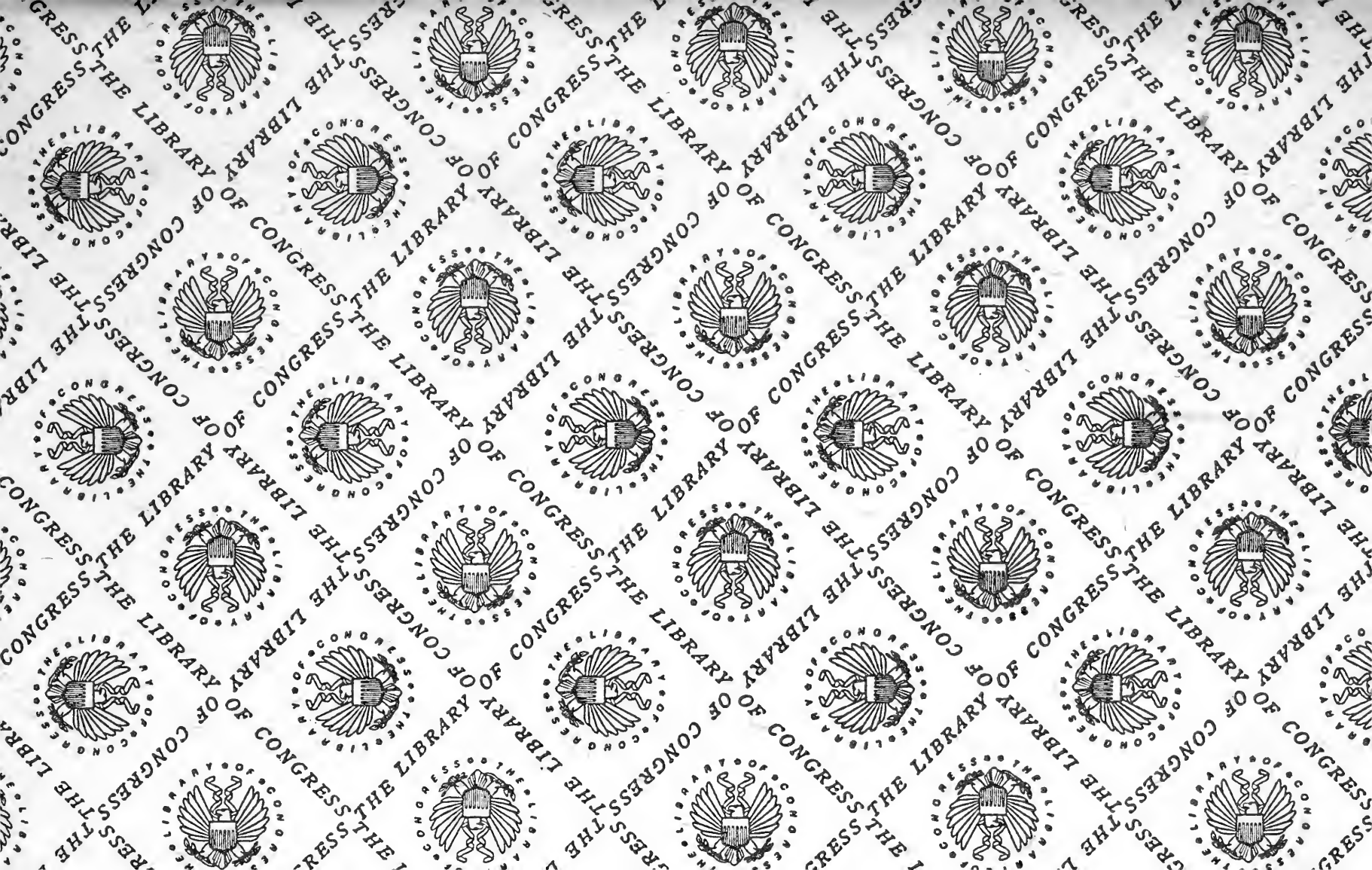

THE LIBRARY OF CONGRESS


THE LIBRARY OF CONGRESS

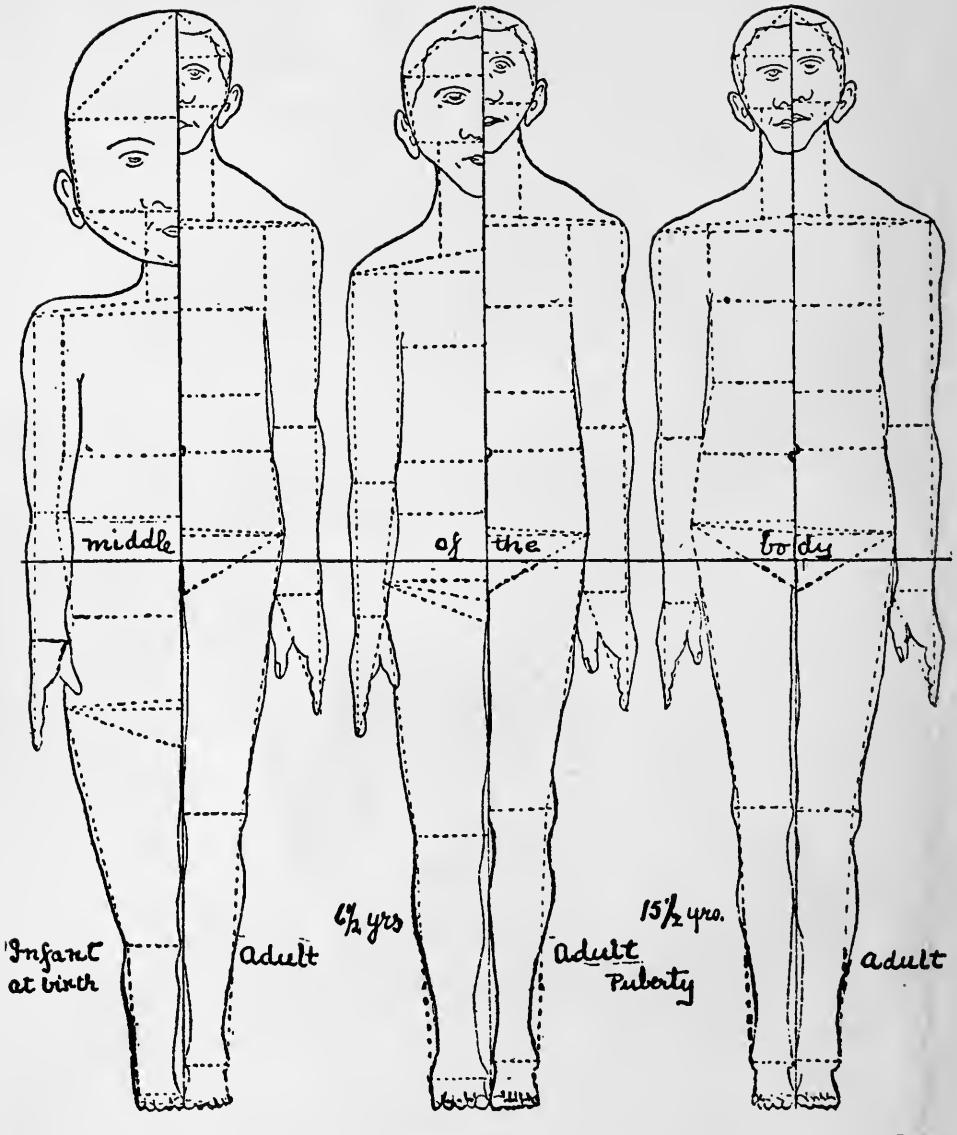


PLATE I.—Proportions of the diverse segments of the body compared to height (= 100) at the ages of evolution.

GROWTH DURING SCHOOL AGE

ITS APPLICATION TO EDUCATION

BY

PAUL GODIN, M. D.

Laureate of the Institute of the Academy of Medicine and of the Anthropological Society of Paris, Professor in the School of the Science of Education (Rousseau Institute) of Geneva

TRANSLATED BY

SAMUEL L. EBY

Sometime Instructor of Psychology, A. E. F. University, Beaune (Cote d'Or), France
Superintendent-elect, Niles (Ohio) City Schools

BOSTON

RICHARD G. BADGER

THE GORHAM PRESS

Made in the United States of America

The Gorham Press, Boston, U. S. A.

" . . . *Ce qui fait l'intérêt, pour l'instituteur, des phénomènes de croissance physique, c'est qu'ils ont une répercussion sur les fonctions psychiques et sur l'énergie du travail mental.* . . . "

ED. CLAPARÈDE,
(*Psychologie de l'enfant, 4me édit., p. 155*)

TRANSLATOR'S PREFACE

THIS translation of Doctor Godin's *La croissance pendant l'âge scolaire* is presented to American students of education for the purpose, first, of introducing the writings of a Frenchman who has long been a student of scientific education. Nearly forty years ago the author began the study of education. He has written much and many of his works have won recognition from the highest scientific societies in France. The author merits a wider circle of acquaintances in the United States of America than he has apparently enjoyed up to the present time. A second purpose is to direct greater attention to the contributions to the theory and practice of education in France. The translator inclines to the thought that American educators have tended too much to neglect French educational practice in the study of education. A more careful study of the work of the French along the line of scientific education will prove fruitful to American teachers and educators.

In itself this work of Doctor Godin should prove very valuable, first, for its scientific method. Within the last decade or two more emphasis has been placed on collecting statistics on physical growth and development of adolescents. Much of this work has yielded no valuable scientific results. Many figures and much data have been gathered but the method of collecting them has been such that the conclusions based upon them are frequently unreliable or unwarranted. This is especially true in respect of measurements of physical growth of adolescents. Measuring a large

group of twelve-year-olds or fourteen-year-olds and then determining medians or averages of weights and heights bears no fruitful results, if, as has very frequently been the case, the measurement is made once for all. It may mean something or it may mean nothing to compare the measurements of a particular individual with the medians of a large group. Whatever it may mean, it gives no significant assistance in the method of educational direction; it gives no insight into the disposition and nature of the particular individual whom the teacher is trying to educate. The only physical measurements worth while are those which admit of comparisons with previous states of development of the same individual. Such comparisons can be valid only when repeated measurements are taken at regular intervals. These repeated measurements are necessary in order to enable the teacher and educator to know the child intimately and profoundly; it makes possible a degree of individualization of education unknown in the past. In its final analysis successful direction of education depends largely upon its individualization. It is along this line that every child—the supernormal, the normal, and the subnormal—will be enabled to realize his whole self. The work here presented is an example of the method of the individualization of educational practice.

The value of educational measurements is summed up in a recent publication.[1] Doctor Godin's work is a model of scientific procedure in educational measurements and avoids precisely the errors pointed out by that writer. It points the way which educators must follow if these failures and errors are to be avoided and corrected.

In the second place, the work is a valuable contribution to our knowledge of adolescence. Of the many books on

[1] Strayer and Norsworthy: "How to Teach," p. 155f.

adolescence, this is one of the highest scientific value. The laws of growth have been determined experimentally in a truly scientific manner. Adolescence has been very carefully and accurately defined. Every teacher who knows these laws of growth and comprehends the meaning of adolescence and its bearing on education of the individual as set forth in Doctor Godin's careful study will be equipped to deal more effectively with the individual under his charge.

The second part of the work is a discussion of the practical application to schoolroom practice of laws and principles of the first part. It gives us the viewpoint of advanced educational practice in France. In the last chapter is found what the author regards as one of the most important features of the book, namely, the "individual formula." This is the first form of expression of the formula. The author himself has pointed out that the formula as it stands here is open to the criticism that the value of the result of the formula bears an inverse relation to the age of the individual. He suggests inverting the fraction, thus making the magnitude of the results bear a direct relation to increase of age of the individual. The author had planned to restate the formula to obviate this criticism. The Great War unfortunately compelled him to defer this correction indefinitely. It is to be hoped that he will be able to perfect the "individual formula" and present it in a definitive form.

The translator acknowledges his indebtedness to numerous persons for valuable help and criticisms. Much of the merit of the translation is due to the assistance of these persons. They are not responsible for any of the faults or defects found therein. Acknowledgment is especially due to Mrs. Emma Rower Cory, A.M., formerly instructor in English, Ohio State University, sometime instructor in French, War-

ren (Ohio) High School; to Superintendent Alfred H. Meese, A.B., B.Sc. in Ed., Shaker Heights, Ohio. The glossary was prepared by Miss Ida L Eby, B.S., M.D.

S. L. EBY

Kent, Ohio,
September 1, 1919.

FOREWORD

I TAKE genuine pleasure, students, teachers and educators, in dedicating to you this work which springs entirely from continuous observation of the child and which brings together the lessons that you have followed.

The lively attention which you have accorded me, dissuades me from every formality except that which has held your kindly interest.

You desire the child to be your unique teacher according to the luminous motto of the School of the Science of Education, *Discat a puero magister!* and you have felt that I was simply trying to be the interpreter of the child. For it is, indeed, the child who by his individual growth affords us a deep insight into the secrets of his life, and teaches us a marvelous lesson of things, in inviting us to discover the *unity* which presides over his manifold transformations and which is his very *person.*

If you know a good deal of his physical individuality, you also know a good deal of his cerebral function which is caused in a large measure by the condition of the brain and by its relations with the rest of the body.

You rendered homage to the enlightening power of the study of growth, when in course of a lesson which caused you to penetrate to the heart of the child, you said to me in a transport which I can never forget: "How intimately you know him, indeed!"

When in turning the leaves of this book your eyes fall on

the expressions: "*We* see, *we* infer . . . ," imagine that we are still working together at the Rousseau Institute. You are present at every page.

PAUL GODIN

June 1, 1913.

CONTENTS

PART I

ANALYSIS OF GROWTH

TABLE OF PLATES

INTRODUCTION

THE pages which follow are not a collection of numbered records which had been published during the twelve years preceding. They are a key to the "individual formula," a working manual by reason of their somatic determination, and they ought rather to be entitled: "concerning growth as a means of penetrating the physical individuality of the child, and pupil."

I have caused the practice of the method recommended to be preceded by a statement of the anatomico-physiological results which I owe to it, namely, a scientific conception of growth, knowledge of the proportions of the body at the successive ages of development, analysis of puberty considered as effect and as cause, laws of individual growth, etc., and some of the principal practical applications to which it has led me.

For the educator who understands how to make an enlightened choice, it is indispensable to know the scientific results and the practical application due to the various methods, and to choose one of them only after a serious examination.

There are two general methods for the objective study of the post-fœtal morphological development of the child: the *simultaneous method* and the *periodic method.* The former examines simultaneously, in some manner, a greater or lesser number of children of all ages. Each child is examined once for all. The *periodic method* examines the same

child periodically throughout the successive phases of his development.

The first method furnishes means useful for general comparisons between different ages, between the two sexes, and between races; but, whether or not it multiplies the number of measurements and of notations, the *individual evolution* of development remains none the less entirely outside its scope with all the biological phenomena which characterize individual evolution, and these are precisely the phenomena which the educator is interested in knowing.

Since here all derives from the periodic method, it is conceived that investigations conducted according to the simultaneous method have only a limited documentary rôle.

PART I

ANALYSIS OF GROWTH

GROWTH DURING SCHOOL AGE

CHAPTER I

REASONS WHY GROWTH HAS A PLACE AMONG THE SUBJECTS TAUGHT IN A SCHOOL OF THE SCIENCE OF EDUCATION

School age is above all an age of growth.—Growth has a double influence on the cerebral function.—New instruction; upon what it is based.—Outline of the data which the study of growth can furnish.—Its termination is the determination of the somatic individuality of the child.

I

SCHOOL age, according to the studies pursued, according to the career aimed at, may stop on the eve of puberty or be prolonged beyond. It can be taken as beginning with the admission to the college [1] or from the time of entrance into the class of the smallest children in the *maternal school* (*l'école maternelle*).

School age is above all an age of growth.—School age extends, in reality, over the greater part of the period of development which the child has to traverse in order to become an adult. School life and growth parallel, and to understand the latter thoroughly, it is of interest to trace it from birth. (Cf. Plates II, IV, IX, and XVI.)

It is quite difficult to admit that school life which places

[1] A secondary school in France.—Trl.

the child in such singularly artificial conditions has no influence on the evolution of growth. It is the duty of the educator to make that influence as auspicious as possible. His first care will be to acquire a knowledge of growth in order to understand its needs and to labor unceasingly to render school life compatible with a normal development of the child subject to the tortures of which school life admits.

Growth has a twofold influence on cerebral functions.— School age is the period of cerebral culture. The brain is not an isolated organ; it forms a part of the organism of which it is a piece, from which it receives nutrition; it cannot be dissociated from the rest of the body at any moment of existence; it must share the advantageous and disadvantageous conditions of life of that organism. The brain is really under the vegetative dependence of the organism, although relatively independent.

In its special psychical functioning, it receives the data from the senses, from touch as from sight. The condition of these senses has an influence on their acuity, on the precision of the information which they furnish, and it is according to the information that the brain estimates the medium, the setting that it judges of the opportuneness of acting, and effects the first part of its functioning.

The senses are the body itself of which they reflect the alternatives of well-being and of discomfort, of good health (euphorie) or pain, alternatives, which echo on the senses functioning in an inevitable fashion. The first part of the psycho-motor operation (Manouvrier) which is the characteristic of the brain, depends on the state itself of the soma, that is, on everything in the organism, which is not the brain. The second part of the cerebral operation borrows the instruments of which it has need, from the motor apparatus whose condition partakes of that of the rest of

the body. How could one picture a cerebral life, a psychomotor function being realized without the body?

Among the causes capable of influencing the states of the organism, growth figures in the first rank during the whole period of elaboration of the adult.

The term growth must be understood as applicable *to all the modifications which concern the dimensions of the diverse parts of the body.* It provokes continual changes in the interior conditions of organic functioning, which for the reasons just given cannot fail to affect the brain indirectly.

But the brain is itself subject to growth, and for that reason it undergoes modifications which would be sufficient to influence its functional activity. The brain is, therefore, tributary to growth in a twofold manner, and it is necessary for anyone who, like the educator, studies its functioning, for anyone who desires especially to grasp the direction of it, to be acquainted thoroughly with the progress of growth.

New instruction; upon what it is based.—This progress is complex and embraces a whole evolution. It is present sometimes at the appearance of organs, at transformations, at variations in the dimensions of diverse parts of the body and in their reciprocal relations. It discovers to the methodical observer the mechanism of several phenomena of life with their individual character. Growth merits indeed a study which admits of its analysis between two syntheses.

We are far indeed from the three measurements, height, girth and weight, taken as the expression of growth and with which the denomination of the measurement of the length of the body, of the thickness of the chest at a certain point, and of the ponderal weight of the mass of the body agrees precisely. These are three of the hundred

twenty-nine measurements of which the metric observation of human growth is comprised, three measurements which represent two one-hundredths of the work of measuring only, to which are added physiological and clinical observations composed of approximately forty-six notations.

The results which I am presenting to you in these talks are based on two thousand observations, on three hundred thousand measurements. I do not hesitate, nevertheless, to ask you to verify them and to check them up as often as possible, when you once have possession of the processes of investigation which form the subject of a special chapter, but which continually support our lessons by the practical conferences which reënforce them.

It is not a matter of your acquiring some vague theoretical notions. You must be prepared to repeat the observations for yourselves with all the exactness of which the scientific method admits, when once the point of departure has been determined among the countless obligations of laboratory research and when the working manual has been rendered useful by daily observation.

This reduction of the technique is justified and valid only in so far as it has been preceded by patient and thorough investigation and as it has thus received the indispensable setting of notions and general ideas without which there is no science. Hence, you need, first of all, to be acquainted with results and laws, and to grasp their applications. But, up to the present time these are found in no study of growth. I shall endeavor to present to you the results, the laws and the applications which twenty years of research have enabled me to discover.

Your direction of education and your own instruction will draw a considerable benefit from these notions of growth because they will lead you to the discovery of the physical

individuality of your pupils. Along that line you will be led to know the ground of each one's mentality; you will be able to adapt your work as educator and teacher to the person of each child. You will realize the most desirable progress in education.

This is the first time that *growth* is taught; all the merits of it will accrue to the hardy innovators who have created the school of the Science of Education, the J. J. Rousseau Institute, and I pray them to receive the expression of my deepest gratitude.

II

The period of growth represents a long phase of the evolution of the human body and its life,—one-third approximately. It corresponds with the moment of transformation, by parts and by wholes, profound and superficial, concealed and apparent, of the entire body and of each of its parts.

Growth keeps up a continual ebullition of the organism which thus presents to the eye of the privileged observer of this biological phase the most intimate of its phenomena. Growth is "the continuous transformation which the body of a child undergoes in its ensemble and in each of its parts in order to become an adult." The term growth is the synthetic expression of all the manifestations of development.[2]

Of what countless and precious notions do those deprive themselves who limit growth to increase of heighth and of weight with or without the addition of the girth of the chest! Alas, the biological phenomena simplified by our haste to scrutinize them, often remain outside of our observation. This is the case here.

The program of the observation of growth is outlined

[2] Académie des Sciences—my contribution of Nov. 13, 1911.

by the very nature of the phenomena, and the working manual, by the systematic stages which the constitution assigns to the phenomena of growth. No one can escape it, unless he declares that the object of his study is such or such particular point of development and not *growth.* It would further be necessary to establish that the elements so isolated by this transforming *synthesis* conserve a direction and are susceptible of an exact interpretation and capable of being turned to account. We shall see later how the eunuch can, according to the three measurements, height, girth, and weight, be classed among the best military recruits. This example is to be retained and needs no comment.

In no case could the observation of the individual, such as I propose and have proposed in my divers reports (1893-1905) for the examination of the French soldier for enlistment, give place to a like confusion.

Nor is it growth, but anthropology with its general and some of its particular views which authors have felt constrained to give as the basis for education.

If growth borrows diverse processes from anthropology, it also takes different methods from statistics. It is furthermore an anatomical, physiological and clinical study. It is by reason of not having taken account of that fact that the attempts of educational and pedagogical anthropology, in spite of the worth and talent of the authors, have not succeeded and that nothing new or practically useful has been contributed from that side either to pedagogy or to education. On the contrary what a vast field of useful and fertile observations spreads out before the educator who gives himself up to the scientific investigation of growth! What precision the multiple aspects of development suggest to him with regard to the individuality of the child!

Outline of the data which the study of growth can furnish. Its termination is the determination of the somatic individuality of the child.—The master, it is certain, is in possession of the substance of his instruction. He is trained in the best manner of presenting it; he is sufficiently acquainted with the medium in which he is called to teach. But does he know each of the little plants which he is going to cultivate? does he know of what kind they are? whether they belong to different species and what those species are? Does he know above all what culture is suited to each of them, exposure, medium, food, soil, etc.? These are some of the cares which constantly have first place in the mind of the gardener; does the master have any solicitude for them? Have the parents, before the master, thought of it?

We see the raising of cattle, of horses, succeed only at the price of a profound study of the race and the individual nature of each of its specimens. Do we not know that the horse trainer, whether he be the master of a riding-school, the trainer of the horse *savant*, of the circus horse, whether he have the talent of Hachet Souplet or the patience of the owners of *Kluge Hans* of Berlin and later of Elberfeld, and even the empiric sagacity of a tamer like Bidel or Pezon; do we not know that that educator of animals always begins by studying the *person* of his pupil and adopts the processes of instruction and of education, which he will employ, only after having adapted them to the individuality of the animal?

The educator of children will acquire more easily and more surely this science of the child, this indispensable knowledge of each one of his pupils if he is enabled to begin by making up an "individual" formula, a kind of abridged synthesis of the somatic individuality.

While studying the continual variations of which the or-

ganism is the seat during the development of the child, the experienced educator will discern what is stable and constant in the person of his pupil. The philosopher, Mr. P. Bovet, has said "a question of education is at once a problem of biology, of psychology and of sociology." [3]

In a general way, the study of growth is that of a moving ground of individual pedagogy. It brings to the teacher the following laws according to which changes are produced, and reveals to him the relations in which are found mingled, at different moments of evolution, these three factors of personality,—the soma, the brain, and the *germen.*

The following enumeration gives a general idea of the instruction and information which, for the educator, spring from the study of the development of each of his pupils and of which we shall consider only the principal ones in these lessons:

Information concerning the state of interorganic equilibrium.

Warning of disturbance of equilibrium which does not accompany disturbance of health.

Information concerning the cause of a psychic disturbance, the reason for which the educator does not know.

Information concerning the phase of development attained by each of the principal factors of the psychological field.

Indication of the "educative moment," of each of the psychological factors, that is, of the freest period for the organ, consequently the most favorable for its education.

[3] Conference held at the General Assembly of the Society of Arts, March 14, 1912, on the founding at Geneva of a School of the Science of Education, by Mr. Pierre Bovet, professor of philosophy at the University of Neuchâtel.

Warning relative to the proximity of the ages of evolution.

Determination of the age of puberty, that is, of the distance which still separates the child from the dawn of his puberty.

Indications concerning the points which the care of the preparation of the ages of evolution must aim at, and concerning the opportune moment of that preparation.

Information concerning the functional cause of asymmetry, of a disturbance of equilibrium, of a deviation.

Precise formulation by the educator with an eye to the individual somatic appropriation of the processes of education and pedagogy.

Data permitting the checking up of the results of a regime, of an educative and pedagogical method, of a process of physical culture.

Data concerning the duration of the periods of repose necessary for recuperation of energy (alternations).

Indication of the "stuff" of which the infant disposes.

Indication of the point, organ, segment, function where special, intensive culture must bear when it is a question of specializing the work, or of correcting a wrong direction or of remedying a short-coming.

Description of the effects of transgression of the phases of repose (alternation) in consequence of too rapid growth; in consequence of infection or of traumatism; in consequence of cerebral superactivity.

Notice of having to prolong the periods of repose of which the educator disposes.

Precise notion of the distance, often remote, at which are manifested the effects of a verified cause, for, the greater part of short-comings which are observed among young peo-

ple of both sexes between the ages of fifteen and twenty years, are only remote effects of faulty preparation for puberty, etc. . . .

Let us beware of falling into the error so frequent among biologists and physicians, which Bergson stigmatises, namely, never treat in any case "the living as the inert." Let us listen to that cry of the great poet, the only one who since Jean Jacques Rousseau, has understood infancy. "One does not know, one does not have the appearance of knowing that infancy forms a part of life." [4]

Growth preserves us precisely from this fault; creative cause of incessant transformations, of continual changes, it does not at a single moment, permit the biologist, the physician or the educator to lose the notion of mutation, the feeling of life in the being which forms the object of his observation.

[4] Jean Aicard, of the French Academy, *L'âme d'un enfant.*

CHAPTER II

METHOD OF STUDY OF GROWTH OR AUXANOLOGICAL METHOD

Methods not to follow.—Worthlessness of isolated measurements.—Measurement of stature becomes useful as soon as it is introduced.—Rhythm of the lengthening of the body.—What is adolescence? The great post-foetal lengthening of the body by the lower limbs takes place between birth and the age of seven years, and not at the time of puberty.—The method to follow is that which the nature of the phenomena and the utilitarian objective of the results of observation dictate.

METHODS not to follow.—The continued transformation which growth bears along with it in the body of children cannot be studied as if it were a fixed state. Observation needs to be renewed often so as to verify the changes which have occurred. That implies a periodical examination of the children, a fact which is far from having been understood by all the authors. The numerous necessary examinations have been reduced to a single one, made once for all.

The reductions have been worked out on the measurements, reductions such that of the relatively few measurements taken by Quételet, there has now and then remained only the measure of height. The fact of considering height as the only useful measure of length has some very grave consequences. Simply reading the results furnished by the

working up of measurements sufficiently numerous makes the liability of error perfectly obvious.

Height is, in effect, the sum of the lengths of the lower limbs, the trunk, the neck, and the skull. Each of these parts has, functionally, a rôle different from the others; each of these segments participates in the total lengthening of one part which is peculiar to itself and differs from that of the segments situated above and beneath. We shall even see that a law controls these differences.

This segmental growth has some correlations which are more or less changed as soon as the said segment grows less or more. The relations which express a certain number of correlations change with them; the interpretations relative to the conditions of life in the organism of the child observed are profoundly different and lead to some deductions quite different in preventive hygiene and in education and pedagogy.

Worthlessness of isolated measurements.—Let us recognize that all isolated measurements are worth nothing; for, even as a solid (globale), growth has still to consider all the dimensions of the solid human body (Plate III); and fatally erroneous, in matter of development of the body of man, are the interpretations of a measurement which represents only one of these dimensions. The measurement of stature teaches us that a person is large or small. That is not enough. Weight does not teach us much more if it has only that of stature to complete its total. For its valuation is increased by the presence of fat as well as by the density of muscular tissue or that of osseous tissue.

One day there were brought to me two children, one a boy of fourteen and his sister aged eleven. The mother was greatly disturbed by their emaciation; the one had lost two kilos and the other one and one-half kilos in ten days. This

was, in fact, considerable, because if children of that age do not gain in weight each day like infants at the breast, they must nevertheless augment by a sufficiently regular and appreciable monthly quantity. But these ten days had been spent in a vacation outing and the reductive effect manifested itself with the two children in equivalent proportions.

I had these emaciated youngsters placed in complete repose, with a diet of a nature to flatter their tastes, two short promenades each day, without running or play, and, providing my prescription were followed, I told the mother that ten days would suffice to regain the lost kilos.

The little girl regained the kilo and a half and several hundred grams in addition. The boy did not quite attain to his two lost kilos but he lacked very little. Quite soon they returned to their habitual activities.

Nothing profound, nothing organic had been attacked in those two children. The change of regime and of habit, the strenuous (*haletante*) life which those little bands lead in order not to miss a train, in order to have time to visit this or that place, impose a certain superactivity on their economy. To the food which the regime of the journey, the conversations with their comrades or haste often reduces a little too much, the little excursionists find themselves obliged to add their reserve. It is this reserve which is formed by the interstitial adipose tissue.

There is relatively little interstitial fat at this age and you see nevertheless what variations of weight its diminution alone can carry with it. The oscillations of weight which one is called weekly or monthly to verify in children who are well, and even in young people, are most often attributable to fat alternately taken up and redeposited by the economy which thus balances its nutrition.

It would also be necessary in order to interpret the weigh-

ing in an accurate fashion, to know the relation between the fattiness and the mass of the body throughout the variations of weight. This is what Malling Hansen appears to have sought, who weighed several times a day each of the little deaf mutes of his institution. But by reason of the special conditions of the life of these poor children, the results could not be generally applied. Thus in the interpretation of the value of weight in the child in the course of his growth, it happens that one takes for an active value what is only an obstacle or at the most, a reserve.

The measurement of stature becomes useful as soon as it is introduced.—Supported by other measurements in sufficient number, weight becomes one of the most important indications. Isolated, the two measurements of stature and weight have no useful signification capable of being interpreted by the educator.

Perhaps the isolated measurement of stature exposes itself to more notorious errors of interpretation than weighing if one judges from the contradictions offered by the results of various authors. From that source springs the unreliability of judgments based on measurement of stature, unless that measurement has been made on the same child at some fixed epochs, the later checking up the preceding, as Buffon, Quételet, Carlier, and Malling Hansen have done. These authors have, in this manner, introduced this measurement into the progress of individual growth and have thus caused to be expressed a real evolution although too comprehensive to have a clear meaning.

Rhythm of lengthening of the body.—In the midst of analytic measurements, that of stature acquires the import of a synthetic value, and it is necessary to know its rhythm. (Plate IV.) The schematic curve above shows that a stature of fifty centimeters at birth, doubles at about the age

of five years, a period at which it attains one meter, and trebles when the child reaches his fifteenth year. Although it has required only five years in the little child to increase his stature fifty centimeters, reckoning from the moment of his birth, an equal lengthening requires afterwards ten years, from the age of five to fifteen years, to be realized. Before his birth, on the contrary, nine months had sufficed to give to the body of the foetus the first half meter.

According to the graph of Plate IV, beyond fifteen years, on the morrow of his puberty consequently, the child grows a relatively insignificant amount in height, namely, fifteen centimeters in five years, say, three centimeters a year, while each year between five and fifteen had added to the stature an average increase of five centimeters. More active had been the increase of height of stature from birth to the age of five years, a period during which each year had added ten centimeters to the earlier acquisition. Before birth, the interuterine elongation is incomparably more rapid still. Monthly, the embryo-foetus lengthens by more than five centimeters; that is, only one month of interuterine life suffices to gain in stature as much as six months of extra-uterine life.

What is adolescence?—With what period of the child's life does the term adolescence coincide? If we should give to the word adolescence its original sense, namely, period of growth, "adolescere," *to grow*, and if we should refer the matter only to increase of stature in order to determine the time of that period, we should logically have to designate under the word, adolescence, the whole span of the child's life without excluding from it the period from birth to five years and still less the embryo-foetal or inter-uterine phase.

Usage is, in a manner, in great contradiction with logic, and the best thing would perhaps be to suppress a word

so completely turned aside from its real sense. But it is acknowledged that the term, adolescence, is applicable to the last phase of childhood, to the peripubescent phase, and that it denotes especially the last relatively insignificant thrust of the lengthening of the body by the lower limbs. (Plate III.)

I have employed the word, adolescent, in this sense in describing "the adolescent type at different puberal ages." It corresponds to prepubescent and pubescent; possibly one could use for its limits, the limits themselves of puberty: the the child becomes *adolescent* when the first hairs appear on the pubis, P^1, and ceases to be adolescent with P^5 on becoming a young man ("jeune homme"). (v. "Phases of Life," p. 103.)

As to stature, considered from the point of view of the method to be employed in the study of growth, had it been followed carefully from semester to semester or even from month to month what could it not have taught us concerning the conditions of its own increase, what could it not have taught us concerning the advantage or disadvantage which its extension confers on the organism, because it is impossible to inform ourselves whether the segments which have elongated are of vital or accessory parts; whether the elongation has been in the bust or in the lower limbs.

As soon as measurements are judiciously multiplied; as soon as the increase of each of the principal segments can be brought out by anthropometric study, the explanations of the rhythm of increase of stature will be found.

It is recognized, as the graph of Plate III shows, that the contribution of the trunk is quite superior to that of the pelvic members during two periods: before birth, next, after puberty; whereas the lower limbs take in the course of these

two periods only a relatively feeble part in the increase of stature.

The great post-foetal lengthening of the body takes place between birth and the age of seven years.—On the other hand, between birth and the age of seven years, the increase of the lower limbs presents the greatest activity; their length doubles between birth and the age of four years, and three more years are sufficient to treble it.

If, in the superficial observation of the children around us, we note in the fact of important increase in the legs, only that which precedes puberty, it is that the child then presents a stature which approaches our own and that our own stature serves as a standard of comparison in order to appreciate the progress of the child. In reality, the great thrust of elongation in the lower limbs takes place very exactly between birth and the age of seven years, and that in a continuous fashion in the child which presents a normal constitution.

From birth till about two years the increase affects rather the framework of the body because the child deserts the arms of the nurse who carried him and moves about on his own legs. But from two years to eight or ten, there is no guiding-mark save for one or another who makes the clothes with which, in disregard of the needs of nature and advice of Herbert Spencer, the baby is tricked out as soon as he leaves his cradle.

The method to follow is that which the nature of the phenomena and the utilitarian objective of the results of observation dictate.—We already perceive by this example the nature of the information furnished by true anthropometric observation of the child. We understand that growth is a thing other than a linear development; we foresee that each

of the many parts of which the body is composed, grows for its own sake, aside from the increase which each part realizes in the most advantageous direction for the entire economy, and we conceive the interest which there is, for the educator as for the physician, in knowing the variations and the laws of this partial development.

One is prepared to understand better the real meaning of the term "growth," "continuous transformation which a child's body undergoes in its ensemble and in each of its parts in order to become an adult," which gives to its study a setting, at once precise, far-reaching, and, what is especially important to us at this moment, marks out clearly the method to be followed which we can formulate thus: *An individual periodic and polymetric method*, if one can express by this term the multiplicity of measurements.

Expressed otherwise, half-yearly examination of the same children from the time when they come into the hands of the educator and continued as long as he has them in his charge; an anthropometric examination by a number of measurements sufficient in kind that each one will find in the others the complement and support which it needs in order to contribute to the expression of the anatomical condition of a function; a physiological and psychological examination; the clinical part admitting only of the recording of the results of the examination worked out according to the same method by the physician.

It is to this combined method of the educator and of the physician, an auxanological method, rigorously employed during long years, that are due the results which follow, with their practical character.

CHAPTER III

METRICAL PROPORTIONS OF THE BODY OF THE CHILD FROM BIRTH TO ADULT AGE

The proportions of the human body and the artists of Egypt, of Greece, of Rome, of the Middle Ages; contemporary artists.—Anthropometric canon of the child at different ages.—Influence of growth on the variations of the proportions of the body.—Partial proportions.—Importance of functional correlations.

I

THE proportions of the human body and the artists of Egypt, of Greece, of Rome, of the Middle Ages; contemporary artists.—In the study of the proportions of the adult, the artists of every period have taken for a standard measure a segment of the body; the height was nineteen times the length of the middle finger in the Egyptian canon, which was probably also the Greek canon (Broca thought so), though Polycletus, a contemporary of Phidias, does not mention it in his treatise on symmetry, written four centuries and a half B.C.

With Vitruvius, the Romans found eight heads in the height of the body. Jean Cousin, then the anatomists since Andry and later Gerdy until Paul Richer, the eminent professor at the School of Fine Arts, himself a great artist, have followed their example.

However, with the beginning of the fifteenth century

there appeared the first attempt to employ a standard measure taken from outside the human body. L. B. Alberti, in his work "Della Architectura" recommends fifty-two measurements which relate to the three dimensions of the body, its height, its breadth, and its thickness. Alberti has recourse to a sort of decimal system which has for its basis a conventional length. "It is, in short," said Topinard, "an essay at rational anthropology and an attempt quite remarkable for the time."

Forty years later, Leonardo da Vinci expresses the wish that a special study be made of the proportions of the child's body. It seems, indeed, that that great artist was the first who understood that the body of the child was not merely a reduction of that of the man; that it had very different proportions and presented for that reason a special artistic anatomy.

Albert Dürer essayed to realize the counsel of his contemporary and established the proportions according to age and sex, but unfortunately he abandoned the standard measure proposed by Alberti. He returned, in effect, to the measurement of the body by the measure of the height of the head, and applied to the child the Roman canon, that of Vitruvius.

In order to find the application of the meter [1] to the evaluation of the proportions of the adult human body, it is necessary to go to the authoritative anthropometric studies of Manouvrier.

Manouvrier's pupil, Papillault, has followed his method in the latter's important study of the average man in Paris and has given, according to the cadaver, a great precision

[1] Admitted as the basis of measurements in France from April 7, 1795 (18 Germinal. An III.), and rendered legal November 2, 1801.

to the relations between them of the different parts of the body in adults of the two sexes.

Anthropometric canon of the child at different ages.—As to the child at different ages of his development, I have been able to establish the proportions of his body by relating to the stature each of the dimensions of length and of breadth of the different segments (Plate V.), and representing those proportions in thousandths parts of the height reduced to a thousand millimeters, to one hundred centimeters, that is, to a meter.[2]

It is to be hoped that the demonstrative figures which have been constructed according to the millimetric notions, will contribute to have the meter substituted for the conventional measurements. The plate of Stratz, which is found reproduced in divers works, owing to the employment of the height of the head as the standard measure, deviates, in fact, notably from reality. I have indicated on page 25 of my study of proportions some of the errors of Stratz and their rectification by means of the metrical measurement.

II

With Plate V we find ourselves in the presence of all the partial developments such as are effected from birth to adult age, and which constitute truly relative growth. In this plate thicknesses (and circumferences) are not shown. A figurative representation of these could be made only by the processes of sculpturing. We are able to follow the extra-uterine ontogeny with the variations which, by heredity and environment, it expresses in skeletal, muscular, and

[2] "Les Proportions du corps pendant la croissance," 6 figures and 9 tables, 1910, work crowned by the Academy of Medicine. Larrey Prize, 1912. Paris, A. Maloine, publisher.

segmentary dimensions, variations which are considered here only in their relation with stature.

Up to the present, we have studied the proportions of the adolescent, beginning with the age of thirteen and one-half years, which, in the average boy, precedes by two years the age of the appearance of the first signs of puberty. We have seen that these variations are relatively insignificant. Plate V, on the contrary, takes the child at his birth and shows some relative variations of great extent. The plate is sufficiently expressive by itself so that a few explanations will suffice for its interpretation. The same holds in the case of Plate I.

It is known that between birth and the age of six and one-half years, the first and second periods of infancy elapse while the third period of infancy extends from six and one-half years to fifteen and one-half, the average age of puberty. This exact division has been proposed by Marian (*Semaine médicale* of November 21, 1896, number 59) and deserves to be conserved for the reason given by the author to which are also added divers ontogentic motives.[3]

The age of seventeen and one-half years closes the period properly called pubescent and opens the internubilo-pubescent phase whose limits and characteristics have been traced in my communication of July 9, 1909, to the Anthropological Society of Paris (meeting of the fiftieth anniversary).

Finally comes the semi-silhouette of the adult at twenty-three and one-half years. These are the five ages portrayed in the plates I and V.

The measurements of the new-born child are obtained in a rapid and simple fashion by means of the measuring ap-

[3] One must, however, acknowledge a fourth phase of infancy, the pubescent phase, which extends to the two years necessary for the inauguration of puberty, from fifteen and one-half to seventeen and one-half, on the average.

paratus which I had made under the name of "auxanomètre" [4] and of which the lower half is instantly transformed into a horizontal measuring apparatus.

The height and breadth of all the segments of the body are, in effect, for the first time studied metrically in their relation to stature in the new-born child and in the child of six and one-half years. The proportions are studied as such. In determining these proportions there is no intervention of preconceived notions which prompt us to attempt to discover a segment susceptible of being utilized to measure the others.

Plates I and V show that the chin of the new-born child does not descend to the lower extremity of the sternum, not even to the nipple of the adult, but corresponds only, to the mid-point of the sternum of the latter. For a more cogent reason, the proportional height of the head diminishing with age, the correspondence of chin to nipple cannot exist later, just as the figure due to Stratz and cited by Cruchet in his remarkable article entitled: "The Child from Two Years to Puberty," from the "Pratique des Maladies des Enfants," vol. I, p. 382, would lead one to believe.

This same figure presents, for example, the ascent of the great trochanter as wonderfully regular and attaining its culminating point in the adult. Now, this relative culminating point is in reality attained in the adolescent of fifteen and one-half years.

Likewise, Stratz thought he was obliged to proportion each of the segments of the lower limbs to the stature and to increase by a proportional quantity the thigh and the leg in proportion to the aging of the child. It is quite otherwise that things take place: proportionally to stature, the thigh changes very little, while the tibia doubles in

[4] Deposited with Maloine fils, rue Casimir Delavigne, Paris.

length from birth to fifteen and one-half years. In the upper limbs the same phenomenon is verified; the forearm lengthens proportionally by more than a third of its length in passing from zero to fifteen and one-half years, and during this time the relative lengthening of the arm is insignificant.

That is a surprising fact to those who expect an augmentation of each segment of a limb, proportional to the increase in stature. Observation shows that, contrary to this theoretic conception, a single segment, the distal, procures for the superior limb its proportional elongation, between birth and puberty.

The pubis gives rise to an important remark: instead of being subjacent to the bitrochanteric line as represented for all other ages, the pubis is situated in the newly born above the bitrochanteric line.

The basin should be then the seat of two successive movements in opposite direction. The first, having for effect, the lowering of the pubis, was taking place from the time of birth on. Then from six and one-half years on, an inverse swing with an elevation of the level of the pubis was noticed. This fact, singular in certain respects, can be considered as established only after checking up by some new series and also by anatomical relations which are better able than the relations to height to establish a fact of this order.

The height of the entire trunk of the new-born child is proportionally quite superior to that of later ages. The same is true, obviously, of the greater part of the segments of the trunk. We note the most striking differences on comparing in Plate V, the first semi-silhouette with the second and third; the height of the thorax of the newly born is excessive; the position of the nipple equidistant from the furculum and the crest of the sternum, is quite different

from that in the two following semi-silhouettes; its neck is shorter by a fourth than it will be at six and one-half years, a period at which it will have in relation to stature the same length as at twenty-three and one-half years.

Instead of meeting the bust below the pubis as in the large boy and in man, the middle of the body is found between the iliac spine and the pubis of the six-year-old child.

In the child at birth, the bust represents sixty-six hundredths of the total height of the body. The horizontal plane which corresponds to the centre of the body cuts it at a point equally distant from the crest of the iliac and the angle of the tenth rib. But the neck shows a width which will not be found present at any other age; and which continues to diminish until puberty.

Other proportions of breadth are similar to those of the neck. They are quite superior at the moment of birth and continue to diminish until puberty. Beyond fifteen and one-half years we know how they behave. But the variations of the cranium, in function of size, in height as well as in breadth, are particularly striking, and give by themselves the principal relief to Plate V. The cranium offers the rare example in the organism of a magnitude modifying itself throughout the years in a regular fashion. It is a matter, in a way, of a relative decrease. That means simply that the brain of the child is, from birth, much nearer its adult dimensions than any other organ and that its content has much less need to grow than does stature.

The grand spread of the arms (*envergure*) offers only a feeble anthropometric interest. It is complex, in fact, and each of the elements which constitute it has been measured for its own sake. However, the grand spread (*envergure*) is not a matter of indifference to artists who sometimes have occasion to look at it in its ensemble, the superior limbs be-

ing extended in the plane of the clavicles. Besides, its relations to stature are often invoked in support of divers theses.

The following are then the relations to size of that magnitude which surpasses stature itself, except in the baby and in seven out of one hundred adolescents and adults. It is to be remarked that of the seven per cent, one only is brachyskeletal while the six others are mesatiskeletal.

Grand spread (envergure) expressed in thousandths of stature.

Infant at birth	92.4
Child of 6½ years	101.
Adolescent of 15½ years	103.
" of 17½ "	103.
Adult of 23 years	106.1

These relations have been established from the fixed averages of series of subjects belonging to diverse regions and to different social strata.

By relative dimension,—and here is an important point of our study where everything is analysis of relations, anatomo-physiological expression of very numerous correlations—by relative dimension is understood the comparison of each partial length, evaluated anthropometrically, to the total length.

If it is a question of the leg, for example, the total length to which one relates it may be the stature, just as I have done in the study of the proportions, but this total length may just as well be the length of the lower limb, its height above the ground, of which the leg represents a part.

From the point of view properly called anatomical, it is different: a segment is compared to another above or below it, or again to the homologous segment of the thoracic member, that is, to the forearm, if it is a question of the leg; but one must avoid relating it to a length, whether it be the

stature or the inferior member, to an entire (*globale*) length of which the segment studied formed a part.

Thus, one will not compare the leg to the stature, unless for special purposes such as guided me in the study of "proportions," one will not compare the leg to the total length of the inferior members, because in one case as in the other the proper height of the leg represents a part of the dimension to which it is related and that thus one part of the quotient would represent the relation of the leg to the leg which is nonsense.

Practically, it is admitted that the greater of the two dimensions, and this applies to the dimensions of breadth as to the dimensions of length, is equal to 100, (by meter) so that the fraction obtained gives in centimeters or in millimeters (in hundredths or thousandths of a meter) the relative dimension of the part compared.

If we proceed by this comparison in the same child, measured six times, in six consecutive half-years, and if there are brought together the divers half-yearly results of the same relation, the change progressively realized is verified.

The proportions are modified, and each of the parts or segments of the body has taken dimensions absolutely or relatively different according to the importance, greater or less, of its functional rôle in the advance of the organism toward its state of perfection.

III

Influence of growth on the variations of the proportions of the body.—Growth has a considerable influence on the proportions of the body which it causes to vary within limits often widely extended. The following are the general considerations to which these variations give place, such as

I have formulated in a communication to the Academy of Medicine (session of June 27, 1911).

Growth modifies in a constant fashion the centesimal relations to the stature of each of the segmentary lengths and widths of the body of man at three different ages: birth, six years, and fifteen years.

Now, from my researches published up to the present time, it results that the evolution of the variations of these relations is dominated by some laws of incontestible anatomical and physiological interest. I state them here briefly according to my communication on the same subject at the session of the Academy of Science, June 19, 1911.

Nature and the extent of the variations.—In passing from birth of the child to manhood, each segment makes its own contribution to stature. Plates I and V. The cranium and the trunk both lose in length and breadth, the former more than the latter: "cranium, ten hundredths in both directions; trunk, nine hundredths in length and four hundredths in width."

The neck loses three hundredths in diameter but gains two hundredths in height.

The superior limbs gain six hundredths.

The lower limbs gain seventeen hundredths, but *only until puberty. Beyond that, they lose one hundredth.*

Alternation of variations.—It follows that if proportional increase is superior to that of stature for one segment of the body, it is inferior to it for the segment situated immediately below or above. Here is a new aspect of the law of alternation which I formulated in 1902 after observation of the growth of bones, in my "*Researches on Growth in Different Parts of the Body.*" (*Recherches sur la croissance des diverses parties du corps.*)

Change of direction of variations.—A segment which progresses relatively more than the stature up to puberty, retards beyond the age of puberty; this is the case of the pelvic member. Such other segment the growth of which is relatively slower than stature before puberty, gains on it when puberty is passed over.

It is thus that the relations to the size of the width of the neck, of the height of the thorax, of the height of the inferior or iliac abdomen, of the height of the ischio-pubic segment, of the width of the basin, of the length of the arm (humeral segment), of the height of the trunk in its ensemble behave. Plates VI and VII.

Puberty has then a decisive influence on the direction of variations, on their orientation. It possesses besides, on the proportional increases, an augmenting (*majorative*) action already noted apropos the absolute increases.

Phases of evolution of variations.—The evolution of variations presented by the proportions of length and breadth of the body is distributed by itself among three phases, presenting a different activity of growth; the first phase ceases at six years, a period at which six-tenths are traversed, and, for some proportions nine-tenths of the augmentation or diminution of the proportional increase; in such a way that the silhouette, at this age, indicates already what it will be in the adult. The second phase extends from six years to puberty; the third terminates at the adult age, at nubility. The most active for the proportional enlarging of the body, the last, is at the same time the least active for its proportional elongation. Plates I, V, VI and VII. The opposite takes place during the first phase; the second phase, the middle, is only a lessened sequel of the first. That constitutes so many applications of the law of alternations.

Conclusions.—1. There are three phases in the evolution of the variations presented by the proportions of length and of breadth of the body.

The first from birth to six years.

The second from six to fifteen years.

The third from fifteen years to adult age.

2. The "law of alternation" governs the proportional increases of the segments of the body, as it governs their absolute increases.

3. The variations of the proportions of length and of width of the body in the two sexes are profoundly modified by puberty which subjects them to its laws of orientation and increase.

4. The proportions of breadth, in general, present some peculiar variations which are correlated with those of the proportions of length of the trunk.

Partial proportions.—Along with the relations to stature which we have just analyzed, the educator cannot be disinterested in the intersegmentary relations which are moreover properly called anatomical relations because it is these relations which constitute the essential part of the *individual formula of growth.*

The first place, among these intersegmentary relations, comes back to the relation $\frac{S}{B}$ of Manouvrier.

B represents the bust, that is, the whole part of the body which rises from the plane of the seat of the subject sitting. On taking away this height from that of the stature erect, S is obtained which answers to a reduced length of the lower limbs.

On classifying the series of children in accordance with this relation, there are seen to group themselves, on one side

the "short legs," on the other the "long legs" and between the average legs. Plate VIII.

With the "short legs" is associated a long bust in order to constitute the brachyskeletal. The brachyskeletal child of thirteen and one-half years [5] who is especially characterized by the relation $\frac{S}{B}$ of which the quotient oscillates in his case around 87, offers numerous anatomical and physiological correlations of this relation.

When the legs (*legs* in the sense of lower limbs) are long, they are associated with a short bust (necessarily, since according to the constituent of the relation, it is by comparison with the bust that the lower members are called long or short) and the macroskele is made up. It is translated by the relation $\frac{S}{B} = 96$ (from 94 to 98 and above).

In the macroskele, the correlations of the relation

are very different from what they are in the brachyskele, and even in the average or mesatiskele of whom the relation oscillates around 90. Plate VIII.

From puberty, especially, the quotient ^{S} is lowered in proportion as the child advances toward the adult state, proving some functional correlations of this relation.

It is in the child specially that the educator has reasons to interest himself in this relation which plays an important part in the individual formula.

Importance of functional correlations.—Later, when we

[5] Dr. Poutrin, assistant in anthropology at the Paris Museum of Natural History, found a brachyskele much more accentuated than that of the child of thirteen and one-half, in a tribe of pigmies of Belgian Congo. "Les Négrilles du centre africain," L'anthropologie, tome XXII, nos. 4-5, 1911.

shall study the make-up of the individual formula of growth, we shall utilize again the intersegmentary relations, but in a slightly different fashion, owing to our dominant prepossession of function: we shall compare among them some capacities. The research of functional correlations will lead us sometimes to compare a thickness or a length to a volume and there will spring from it some important information for educational or pedagogical administration.

The measures which we have placed on the individual record card, supply to us other factors of relations which we shall always be interested in calculating in view of the direct and immediate information which they can procure for us, in view of the comparison of their quotient with that of the same relation in other children, or with itself in the same child some half-years later. Such are: the relation of the length of the foot to the height of the lower limbs; the relation of the length of the lower limbs to the height of the trunk (distance from sternal furcula to the pubis or vertical diameter of the trunk); the relation of the height of the trunk to the length of the neck or to that of every other segment of the body, cranium, foot or hand, or superior limbs; the relation of the length of the superior limbs to the length of the inferior limbs, the relations of the breadth to the height of some segments, such as the foot, the hand, the trunk, the cranium.

The educator who exercises his activity in multiple directions, will be interested in preoccupying himself with these diverse relations only so far as he will be invited thereto by the individual functional correlations, leaving to the physician the care of estimating the digression of the development which he might believe ought to be indicated to him.

CHAPTER IV

INFLUENCES WHICH ACT UPON GROWTH

Influences which act upon stature.—Influence of food, of sex, of race, of heredity, of season, of gestation, of exercise.—Influence of function of reproduction.

INFLUENCES which act upon stature.—The studies which have been made up to the present time of the influences which act upon growth have borne only on height alone or on height and weight.

We have seen how far height fell short of representing "growth" of the body, of expressing what scientific analysis, on the one hand, and educational application, on the other, can and must understand by "growth."

If certain influences act upon height and augment it, are they to be investigated by the educator? The educator, in order to solve this question, will commence by rendering to himself an account of the organic and biological value of height, of the individual value consequently, in the next place, of its social and economic value. He will investigate the output in useful work, of people according to height, and he will soon have caused to be recognized throughout history that the races of small or medium stature furnish an output often superior, at least equal, to that of races of tall stature.

That might appear to be in contradiction with certain facts of modern and contemporary history, but this impression will not withstand a more searching analysis of

the conditions and mechanism of output by which voluntary work is differentiated from forced work.

They are no longer slaves whom we see at work, but peoples of other nationalities as is observed on English merchant packets, for example, while we see only Japanese on Japanese packets. Anglo-Saxon wealth springs in part from India, and from the Cape where the workmen are negroes, Hindus and Chinese.

If the arms belong to men of small or medium races, are men of tall stature who command, who direct, perhaps more richly endowed from the point of view of cerebral quantity? The answer is given us by these lines [1] of L. Manouvrier whose excellent studies on the brain are known and appreciated in the scientific circles of the whole world: "The qualitative superiority (of the brain) is a condition of intellectual superiority; the quantitative superiority is another thing, morphological superiority is still another. And it is because there are some diverse anatomical conditions in relation with the intellectual superiority that any of these conditions would not be, singly, a sufficient base to evaluate the intellectual superiority," and further on: "The average of these 62 Parisians, all very tall, is equal to 1365 grams.[2] *One could, therefore, explain by even a very great superiority of height, and otherwise not demonstrated,* only a part of the quantitative cerebral superiority of the series of distinguished men."

It is not, we may conclude, because the race is of tall stature that it necessarily possesses a more voluminous brain, and should the race possess it, that would not be a sufficient guarantee of intellectual superiority. The con-

[1] "Dictionnaire de Physiologie," Charles Richet, 3rd part, Vol. II, pp. 672, 688, 689.

[2] Weight very near the average weight of the adult brain in general (V. Vierordt, Boyd, Manouvrier).

clusion is that the educator is not at all to seek intellectual superiority for his pupils in the superiority of stature.

But it would suffice that he be able to anticipate height as a factor of health and strength in order that he might be authorized to "cultivate the elongation of the body." Now, every one knows that the vigor of the organism is ordinarily manifested by the importance of the other dimensions of the body, breadth, thickness, bulk, but not by the height, unless this be unaccompanied by the others.

The dimensions which correspond in a high degree to organic force are the natural adjunct of mountaineers, agricultural laborers, porters, and those men are not generally distinguished by the height of their stature.

To what influences, moreover, is the increase of height of a boy or girl beyond the limits set by heredity due? In other words, what are the conditions which cause a child to grow larger than the father and mother? What we observe every day, leaves us hardly any doubt on this subject, and, on the other hand, statistics show it. It is not at all in the country that the descendents gain in stature over the progenitors. It is in the city; life in apartments, life at college, favor the superiority in stature of the child over his parents. Exaggerated increase in height is as well the effect of cloistering, of insufficient air, of activity and of light, as is constantly shown in children who rise from the sick bed after a long illness. The increase of height is in all these cases the result of the growth in length of the long bones of the lower limbs. The bust takes only an inappreciable share in it as measurements in convalescents have demonstrated to me.

According to our analysis of the increase of height and of the increase of its constituent elements, we know that beyond puberty, the lengthening of the lower limbs becomes

normally very feeble and that already, from the age of eight years, the lower limbs grow less and less each year.

Therefore a boy or girl from thirteen to sixteen years who grows noticeably only in the lower limbs is already, on this ground, open to suspicion to the educator who is forewarned.

If it were permissible to reason thus biologically, one could say that of the two sources of growth from which the long bone draws, dating from the period of puberty, the one periosteal, is the expression of nutrition, the other, cartilaginous, is the expression of lack of nutrition.

That has at least the advantage of marking out clearly for the educator the choice which it behooves him to make and to fix the direction in which he must orientate his action.

It is sufficient to take away from parents the ambition of seeing their children become larger than themselves. What "race" does not do, it is necessary to avoid provoking, at least in what concerns stature. So much the more as increase of stature under the influences which precede, is always made to the detriment of dimensions advantageous for the body.

Owing to the state of illness of the child subjected to these influences the phases of alternation (I shall return later to the biological rôle of alternation) are transgressed. While, in the regular evolution of growth, a phase of increase in bulk succeeds a phase of increase in length, it is no longer so in the case of the poor young prisoner of the urban apartment and of the establishments of instruction, and one of the phases is prolonged indefinitely; the worst is, it is fatal.

Stature, the highest that phylogeny admits of, is realized then, saving exceptions, to the detriment of the dimen-

sions of the body, the most advantageous for its strength and the most useful for its preservation from sickness.

Conceive now to what errors of interpretation we should expose ourselves deliberately if we should judge of growth by height, if we should want to evaluate according to their effects on height, the influences which are susceptible of acting upon growth.

We know now that the study of the influences of these diverse factors on height instructs us very little in what concerns the action of these factors upon growth, in spite of the corrective contributed by weighing, which divers authors point out.

Logically we shall consider as very useful documents the studies made in this direction, but for the word "growth" we shall substitute mentally the word "stature"; we shall keep in mind that we do not have the right to come to a conclusion of the one from the other. That fact established, the following is a résumé of the notions acquired relative to the different influences on height.

The influence of nutrition which is here suitably called *alimentation*, because nutrition is the resultant of a host of organic factors of physical, chemical, and biological order, which appears to depend especially upon heredity and placental alimentation, and of which we are within reach of verifying only the effects. Alimentation which represents only one element of it, the external element, is, on the contrary, in our hands, an undeniable means of action and we ought to observe its influence with the greatest care. According to the writers, it appears that, all things being equal, and especially the conditions depending upon the race and family inheritance, stature becomes greater under the influence of a substantial alimentation. The study of Carlier: "Des rapports de la taille avec le bien-etre" (some

relations of stature to well-being) is one of the best of which we are possessed with those of Villermé (1829) and that of Manouvrier (1888). But these studies do not only consider the alimentary influence, they refer to all the surrounding conditions. It would also be necessary to know whether the stature of the descendants thus favored has exceeded that of the progenitors.

Influence of sex.—Assuredly the average stature is less in the feminine sex; as to the manner of behavior of the increase of the stature throughout the successive ages, the writers are not in accord. Variot and Chaumet (1906) do not subscribe to the conclusions of Schmidt who disapproves of Quételet's viewpoint. All of that is especially a matter of methods of observation, Quételet alone having observed with constancy the same children from age to age.

Influence of race and heredity.—These two factors can hardly be separated as H. de Varigny [3] remarked. The tables cited by that author are the best proof of the kind, and it is necessary to abide by the tables, for everywhere confusion reigns between "increase of height and growth," whence the difficulty of squaring the proofs on man with those which breeders have collected on animals, who do not seem to fall into the same error.

STATURE ACCORDING TO RACES

(after H. de Varigny)

Tall stature, 170 cm. and over.

Patagonians, 185 cm.; Comanches, 180 cm.; Polynesians, 176 cm.; Iroquois, 173 cm.; Scandinavians, 171 cm.; Scotch, 171 cm.; Zulus, 170 cm.; Esquimaux, 170 cm.

[3] H. de Varigny. Art. Croissance du Dictionnaire de Physiologie, Ch. Richet.—F. Alcan, édit., 2e fasc. du t. IV.

Above the average, 165 to 169 cm.

Nubians, English, Germans, 169 cm.; Belgians and Arabs, 168 cm.; French, 165 cm.

Below the average, 160 to 164 cm.

Australians, Chinese, Bavarians, Esthonians, 164 cm.; Jews, 163 cm.; Japanese, 160 cm.

Small, less than 160 cm.

Malays, Annamese, 159 cm.; Ostiaks, 156 cm.; Laplanders, 153 cm.; Siamese, 152 cm.; Bushmen, 144 cm.

De Varigny does not give the sources from which he draws the facts of these tables. Polynesians, Arabs, Esquimaux are evidently too comprehensive denominations. Among the Arabs I have personally verified some ethnic groups differing greatly, and, on the other hand, the average height of Esquimaux which I have been able to measure was 147 cm. and did not attain to 150 cm. even among those of the young men of the Hudson Bay shores, who kept on their moccassins. They were some thirty years of age.

Let us remember that Broca attributed the predominant influence, in matter of stature to race.

Influence of climate.—De Varigny rightly makes us observe that no conclusion can be drawn from these collected data because no account at all has been taken of racial difference, and because the method used is not good. The fact is that the theory of the reductive influence of cold on the proportions of living organisms is hardly verified for man who counts the tallest of his representatives in the frigid countries, such as Patagonia, Scandinavia or Scotland, and who presents races of pigmies in Maylasia (von Luschan), in Congo (Poutrin), etc.

Under the equator live some tall men and near the poles

are found the Lapps and certain groups of very small Esquimaux (147 cm.). According to that, climate exercises no appreciable action on adult stature; man's tallness or shortness remains independent of latitude.

When one gets a clear idea of it, he is convinced that climate has no relation with the manner in which, under the diverse latitudes, the different parts of the body are developed from birth; climate has no relation with the modality of growth, with its rhythm.

Influence of seasons.—The patient researches of Malling Hansen, who followed day by day the height and weight of the deaf mutes of his institution at Copenhagen, and even repeated the measurement and weighing several times a day, furnish some very interesting ideas the import of which would be still greater if his subjects had not been infirm, subjected to institutional life, and if he had not limited himself to the measurement of stature and weight.

Be that as it may, Malling Hansen recognized that when weight augments, height does not appear to increase, and vice versa: "During autumn and beginning of winter, the child accumulates weight; but height remains stationary. At the beginning of summer, weight remains almost without change, but the child shoots up in height, like the trees," etc.[4]

According to Combe (of Lausanne) season exercised its influence already before birth; boys born from September to February were shorter than the boys born from March to August; girls were shorter when born from December to May. The younger children of Daffner always showed a summer growth superior to winter growth (October to April.)

[4] De Varigny, *loc. cit.*

The researches of Carlier [5] which preceded the above and seem to have inspired them as they have inspired mine, had admirably determined the influence of the seasons relative to weight, to thoracic perimeter and to height which the author sums up in the following table.

Average total increase in summer and in winter of the perimeter (subpectoral thoracic girth), of weight and of height.

(From 13½ to 15½ years)

Perimeter	winter..... 4.7 cm.	Difference 4.2 cm.	
	summer..... 8.9 cm.		
Weight	winter..... 9.489 kg.	Difference 1.778 kg.	
	summer..... 7.711 kg.		
Height	winter..... 6.5 cm.	Difference 1.2 cm.	
	summer..... 7.7 cm.		

However, as Buffon had already remarked, between birth and five years, the seasons are without influence on increase of height. Beyond five years the influence becomes very evident.

The influence of gestation.—There is no antagonism at all, as Herbert Spencer thought between these two evolutions: growth and reproduction. Every physician has met young mothers who kept on growing between the birth and the weaning of their first-born and even later. Nubility, however, we shall see, is really established only with the completion of the growth of the different parts of the body, and consequently of height.

The influence of castration will be discussed in the study of the influence of the reproductive function.

Reciprocal relation of illness and growth.—There remains for us to get a brief notion of the influence of illness

[5] Dr. G. Carlier, physician major of the army, *Extract des Mémoires de la Société d'Anthropologie de Paris,* 2e série, t. IV, 82 pages. "Recherches anthropométriques sur la croissance."

on the increase of stature; and of growth on illness or, more exactly of age on illness.

We have already seen above that after a general fashion, illness increases height particularly during the period of convalescence. From "preliminary reservation," it cannot be a question in these cases of explaining the source on which the organic effort of growth draws; no more than of gathering up ("recueillement") for the organism has just undergone a particularly exhausting test while meeting the obligations which an infection necessarily brings along with it.

As to the phases of growth to which the organism becomes more vulnerable, there is none of them which may not be the fact of a fault in bringing up or education, perhaps in both, unless both have been preceded by the action of an unlucky heredity.

Placental alimentation has its repercussion up to the time of puberty. The feeding of the nursling makes a good or bad digestive apparatus, which becomes from that point a gateway closed or open to the various infections to which infancy is exposed. Now, as Marfan has demonstrated, the most of the infections of young age penetrate into the organism by way of the digestive tract.

I have been able to determine that it is also the digestive tract which gives access to the greatest number of infections, in the child, up to the end of the pubescent phase. So that the receptivity of a child to disease during the course of its growth, is in great part the work of the mother who has been a good or bad placental nurse, a good or bad nurse at the breast, or who replaced the breast with the bottle, creating with the greatest ease that "latent dispepsia" which Marfan describes and incurring the responsibility of later infections.

Thus everything leads back, in matter of relation between growth and sickness, to individual conditions.

Influence of exercise.—Carlier recognizes, as the authors who have preceded and followed him, withal, that height does not appear to be influenced by physical exercises. However, permanent living in the open air, continued erect posture, long daily walks, hard work, do not favor in the child development in height but in breadth, in thickness, in bulk, that is in strength. In the city, this fact is observed in the young workmen who wait on masons, for example.

Animals which are deprived of exercise by keeping them sheltered from the light, as I have repeatedly experimented on animals not subjected to the regime of fattening, do not delay in stretching out and surpass in a relatively short time the height of subjects of the same age and more. For rabbits and for chickens, nothing is more easy to verify.

During eight years, I followed some methodical investigations concerning the influence of gymnastic exercises on the growth of the different dimensions of the child. I did not stop with his stature, his girth, and his weight; I took other measurements. The following are the conclusions to which I have been led in what concerns these three measurements:

In adolescents from fourteen and one-half to eighteen years old, gymnastics on apparatus (stationary bar):

1. Does not injure growth in height.

2. Procures for the thoracic cavity more amplitude than it would take on spontaneously.

3. Increases the density of the tissues, the weight of the body, etc.

The import of these conclusions is due to the method pursued, to the number of scholars observed, *two hundred*, to the *continuity of the observation on the same children from*

semester to semester, etc., all conditions usual to the *auxanological* method, which I conceived and have continuously applied since 1891-1893.

The grouping of pupils into *gymnasts*, *non-gymnasts*, *sickly gymnasts* and *sickly non-gymnasts* has permitted of studying the diverse categories of scholars in function of gymnastic exercises and of always reserving a number of children for proof (témoins) equal to the number of children observed in order to permit valid comparisons.

The influence of exercises was investigated in its effects on growth. *It was advisable then to make the starting point very clear-cut between the development due to the spontaneous evolution of growth and the development due to exercise.*[6] For that purpose, it was necessary that the study of growth precede that of the modifier, the agent of physical education. This is what was done.

Finally, I took account of distant effects, of remote results of the exercises on growth, while continuing to observe the pupils beyond the period of gymnastic training.

These advantageous conditions of observation were found realized then for the first time. They have not been repeated since. Also, I believe I ought to lay stress upon it in order to cause you to note the complexity of the experimentation when it has for its object growth, for subjects children, that is, organisms in process of continuous transformation, as much as to make you note especially the results which differ in certain aspects from the results mentioned above, by the preceding and following authors. My memoir was published in 1901 by the Anthropological Society of Paris.

These researches have had at the same time as end the

[6] An indispensable method in order to arrive at a classification of exercises according to their effects.

establishing of a method of checking up of the effects of physical education by anthropometric means.

For this reason they represent an application to education of the auxanological method and will be stated with their graphs and tables in the part of this work which treats more specially of applications to education and pedagogy, of the results of my researches on *Growth of the different parts of the body.*

The influence of *consanguinity* on growth is poorly understood in man and besides difficult to study, the terms of comparison being lacking. In animals, observation assumes the precision of an experimentation. It is stated that consanguinity represents only a hereditary accumulation in the same direction, as far as the notions acquired at present are able to give an account of it (v. Mendel's laws).

Influence of function of reproduction is considerable.—It is of the greatest importance for the educator to be acquainted with it. It will be treated in Chapters V, VI, VII, and VIII. It is puberty.

CHAPTER V

PUBERTY—INFLUENCE OF THE REPRODUCTIVE ELEMENTS ON GROWTH

Determination of the dawn of puberty.—Some causes of error.—Most favorable season for the dawn of puberty. —Almost the whole of puberal phenomena escapes him who does not repeat semiannually his observations on the same subject.—What is puberty? Definition.

IF we desire to study the influence of the function of reproduction on growth we must approach it by that one of its manifestations which is the most easily seized upon.

We shall see next if we are able to reach in each direction, to the age which precedes and to the age which follows, and to search into and understand the action of the constant element of the evolution of reproduction, of the *germen*, not only on one dimension of the body but on all the dimensions of the organism of the child, considered in its totality and in each of its parts, just as in the proportional relations of these parts among themselves. It is, in a word, the action of the *germen* on growth which we shall attempt to determine, abandoning the beaten paths and the simple verification of coincidences.

The importance of this study for the educator is further increased by this fact that growth reveals some of the obscure phases of the evolution of the *germen*. Reciprocally the *germen* makes us understand certain parts of the mechan-

ism of growth by the mode of influence which it exercises upon it.

. . . . . .

Puberty is announced in both sexes, just as its name indicates (pubes, hair) by the shoot of hairs on the skin which covers the anterior part of the bones of the basin called pubis. Hair shows itself first at this point, then, a little later in the armpits when the hairs of the pubis are already quite developed.

In woman, the appearance of the menstrual flow precedes by very little that of the axillary hairs according to Dr. Martha Francillon, and determines the period of the dawn of puberty. The flow gradually increases in abundance and reaches its fulness in the girl in good health at the same time that the growth of the hair of the armpits and pubis is completed.

In man the essential phenomenon escaping investigation, the secondary signs assume greater importance, and it becomes indispensable to arrange them in order of importance for the purpose of obtaining exact information.

Determination of the dawn of puberty in boys.—Let us note by P^1, the appearance of the first hairs on the pubis, other than the downy hair, besides hardly visible, and which fall at the invasion of the real hair. The boy has an average age of fourteen and one-half years.

At the following half yearly measurement, which is at the age of fifteen years, the hairs have become more numerous and the voice has taken on a degree of hoarseness which it did not have before. You note down P^2 and the change of voice, summer or winter 191—.

The following semester, the subject reaches fifteen and one-half years; the hairs have become still more numerous

on the pubis, longer, and form a light fleece, but sufficient to conceal the skin of the region. You record P^3. But, at the same time the attention of the observer being at each examination methodically directed to the whole cutaneous surface, he discovers in one or both of the armpits a light down of analogous color or a trifle lighter than that of the down on the pubis. You mark A^1.

At this time, fifteen and one-half years, there is then on the appearance of puberty the following data: P^3 A^1, *change of voice*, $15\frac{1}{2}$ *years*.

Does the color of the scrotum change? Different authors mention a scrotal pigmentation. If the color of the scrotum is modified, it is very little. It is frequently a matter of an appearance due to the wrinkling of the skin by a stronger and more sensitive dartos, the subject being deprived of clothing. To the darkened grooves which result from it, is added a sombre tint which the few hairs more or less dark, disseminated over its surface, give to the teguments. That is far from taking place in all cases. If this sign were constant, I should propose to note the reënforcement of the dartos, a flat muscle whose contraction produces the cutaneous puckering by the same mechanism as on the forehead, for example.

The volume of the genital organs is modified only in exceptions at this epoch. Their augmentation has been verified in the whole of my series of the first and second rank only in the neighborhood of seventeen years. Consequently this modification does not occur at an opportune time to help the researches of the observer who purposes limiting himself scrupulously to the notation of statements which are certain.

Physicians would have definitely established all those facts long ago, if they had been called to observe periodi-

cally, the same subjects in a nude state. But in the lycées, colleges, or schools, as well as in the families, the physician is called only to the bedside of the sick child, and, on the other hand, in the consultation of an educational institution, as in that of the hospital, he has an opportunity of observing in its ensemble the nude body of the adolescent only if the latter is afflicted by an affection which makes necessary a complete stripping, which is the exception. Besides, his observation would have worth only if it were repeated in the following half-year intervals.

The grouping of these three signs, P^3, A^1, *change of voice*, appears sufficient to establish the time at which puberty is settled. It is to be remarked that the change of voice has coincided in general with P^2, and was able to be recorded at the corresponding measurement at the average age of fifteen years. It precedes by about six months the time at which one can record $P^3\ A^1$.

In order to obtain all the desired precision and to give to each sign the importance which it merits, it is necessary to be acquainted with the chronology of these phenomena, the average age of the appearance of each one of them. For change of voice the average age is fourteen years and eight months, while P attains the third power, and A the first, at the age of fifteen years and six months. We shall see that the change of voice is often difficult to observe, and that in the great majority of cases it is expedient to consider the dawn of puberty as answering to $P^3\ A^1$, that is, for the average, at the age of fifteen years and six months.

I remind you by reason of its singularity and of the functional and pathological correlations which you can verify, of a fact which I mentioned already in 1902, namely, the appearance of hair later in the left armpit than in the right or the reverse. That is met with only in some cases.

In all cases, on the contrary, I have observed the delay of the axillary shoot on the pubic shoot, a delay of a year on the average, as the difference of powers of P and of A in the expression P^3 A^1 indicates clearly.

It is conceived that this order of chronological hierarchy of the facts of growth can be observed only on condition of following the *same subjects from half-year to half-year.*

Some causes of error.—It may happen that the downy hairs are mistaken for a beginning of the puberal shoot; the fact is rather rare but it can occur. Here is an example: number thirteen of my series of the first rank (100 subjects from thirteen to eighteen years) entered the preparatory school at thirteen years and four months, presenting on the face and temples, on the back, on the posterior side of the arm, on the anterior part of the legs, some downy hairs in abundance, lying flat, and of a brown color.

In April, 1897, I ascertained on the pubic region, some fine hairs quite abundant. I noted $P\frac{1}{2}$. In October of the same year, the disappearance was quite noticeable and I was obliged to lower the power of P to $\frac{1}{4}$. In the month of April following, April, 1898, the pubis had regained its fine down of 1897 and merited again $P\frac{1}{2}$. When the measurement of October, 1898, took place, the pubic region was wholly smooth and gave place to the notation P^0. The same condition existed in April, 1899. Finally, in October, 1899, some hairs no longer down, but downright black, stronger and more abundant, covered the pubis in part, and were equal to P^1. Then there succeeded on the record card of the individual from semester to semester: P^2 A^1; P^4 A^3; P^5 A^5; it was a matter of a subject measured ten times, the great majority of his comrades in the same school having been measured only nine times, that is, at nine consecutive semesters.

In the matter of the change of the voice, I have only a few remarks to add. It is clear that it is not sufficient to note one time in passing, in traversing an agglomeration as physician or explorer, that the voice of a boy or girl is dissonant, hoarse or low to conclude there is a change of the larynx.

The change is, when it is produced, always the same phenomenon arising in the course of adolescence with the same characteristics, with the same sequence of signs. But it can very well not have occurred or pass unperceived. The state of the voice during change, aside from some remarkable cases, is only a modification of the anterior state; acquaintance with this anterior state, with the sonorousness and with the timbre customary in the voice of the child, will permit the estimating of the changes in him, in proportion as they occur. There also, the indispensable condition of a good observation is to follow the same subject throughout the years of adolescence.

There are children, for whom the observer experiences some difficulty in assigning a date to this phenomenon, in appearance so striking, of the change of the voice. In such adolescent, the modification is made in a manner quite insensible to the best trained ear. That appears to arise from the fact that the voice is modified at once in the whole range of its scale as is often observed in girls. Hence, the absence of discordant sounds and of hoarseness; the tone becomes deeper by a slow and gentle progress, so that the change can occur unperceived by the most attentive observer.

I have met in schools some children with a deep voice upon their arrival, when they did not yet present any sign of puberty. Whether it be a matter of a premature change or of a special individual conformation, the result is nevertheless that it is almost impossible to determine for that

class of subjects the time at which this sign of puberty really appears.

In numbers 10 and 17 of the series of the first rank (100 children, thirteen to eighteen years) the change of the voice was unnoticeable; it was completed without my succeeding in fixing the date of it. The other attributes of puberty manifested themselves between fifteen and sixteen years as for the greatest number. The "bass" voice gave rise to the same results for numbers, 6, 25, and 39 of this same series.

In 100 boys, 70 changes can be determined; 5 can not be determined; and in 25 there is no change. The other secondary signs occur at greatly variable periods of the evolution of puberty, so that they cannot be systematically used when it is a question of determining the time of appearance of puberty.

. . . . . .

Most favorable season for the dawn of puberty.—The warm season is more favorable than the cold to the dawn of puberty in the adolescent. Out of 100 subjects, there are 12 for which the appearance of puberty could not be determined, either because it had already taken place at the time of admission to school or because it had not manifested itself before the last measurement.

SEASON OF APPEARANCE OF PUBERTY

Number of observations	100
Warm season	53
Cold season	35
Indeterminate	12

Almost the whole of puberal phenomena escapes him who does not repeat semi-annually his observations on the same subject.—It is not enough to examine the child once a year, if it is desired to discern the season of the appearance of

puberty. Semi-annual observation is indispensable as well for the determination of pilar signs as for the determination of the progress of puberty. For want of the periodical examination of the same subject, phenomena of all kinds also escape, and nothing can be known of what has immediately preceded or immediately followed the dawn of puberty.

The year, in respect of its temperature, not being divisible into less than two periods, the warm season and the cold, and the half-yearly measurement, April-October, for example, taking account of it, it follows that the modifications marked in October, are changes realized during the warm period, *changes with respect to the results of the measurements and notations of April preceding.*

An annual observer would not have seen his subjects again from October to October; the changes noted by him would be only by comparison with the results of the preceding year; the phases of evolution effected in the course of the cold season would remain unknown. For the annual observer, the term "prepubescent" designates the subject during the "year" previous, while for the semi-annual observer the same term is applied to the state which has immediately preceded that to which the present measurement is applied. The difference is considerable. Not merely by reason of the divergence which that engenders, but especially in the interest of reality. Let us recognize, however, that the qualifying term *prepubescent* can, with as much reason be attributed to the whole period of growth which stretches between birth and puberty.

What is puberty? Definition.—And now, since the conditions of its appearance are well determined, let us ask what puberty is.

The comparative study of the half-yearly observations of my two series of peripubescents (230 subjects from thirteen

to eighteen years, the same followed at six-month intervals) constitutes the basis upon which the notions rest which have just been developed touching the phenomena of puberty and the correlative phenomena which interest the direction of education of the child.

The deductions of this comparative study can be very numerous as soon as puberty is considered in its origins, its mechanism, in its effects as it is here. But it is essential that each of the deductions proceed exactly from the facts observed, that each induction rest on these facts throughout the whole extent of its base.

Up to this point, puberty was especially considered as a phase more or less difficult to traverse, and beyond which, the child, become a young man, found himself in a state to procreate. Physiology qualified it by "the period characterized by profound sexual modifications." (Gley). The special recent studies designate it as the "post-embryonic period specially consecrated to the establishment of the genital function representing the human homologue of the sexual maturity of animals."[1] Dr. Cruchet in his article "Puberty" of the "Practique des Maladies des Enfants" presses the analysis of puberty farther than most authors. "In résumé," he writes in 1909, "we shall designate under the name *puberty* the whole period of growth which extends from twelve to fifteen years in girls and from fourteen to eighteen years in boys. It includes the series of modifications of physical or psychical order which have for effect the transforming of the organism of the child into a new organism, that of the adolescent."

I do not believe that we ought to content ourselves with coincidences which, in the main, these diverse essays at definition limit themselves to establish. That cannot suffice us

[1] "La Puberty," 1906, by Dr. Martha Francillon.

as physicians, as educators. It is necessary for us to attempt to go farther, to make use of the latest acquisitions of science in order to go back to the *causes*.

If we should succeed in this line, we should certainly bring some light into the knowledge of the nature and rôle of puberty; into the knowledge of the relations of the germen and of the soma. I propose then to pass immediately to the final synthesis and to define puberty according to its cause, its character and its action.

Definition of puberty

Puberty is that phase of growth in which the matured germen provokes a new embryonic elaboration of the soma in order to mature it in its turn, and to perfect thus the function of reproduction.

This definition, if it is in accord with reality, ought to enable us to understand the phenomena of puberty, not only in general, but also in each individual in particular; it ought also to put us on the scent of the explanation of a good many of the phenomena.

Understood, and partially explained, puberty ceasing to be an enigma for the educator, it depends upon him to make it a point of support and to find in it a bit of illumination, in the difficult hours of the direction of education of the individual, as well as the indispensable physiological basis of a psychological puberty adequate to reality.

While waiting, we are going to attempt our best to scrutinize the profound nature of this phenomenon and we "shall not turn aside from any detail into which its analysis will lead us.

CHAPTER VI

PUBERTY (CONTINUED)

Analysis of puberty by the means of the phenomena of growth which it determines.—Augmented growth, reduced or arrested growth, total growth or appearance of organs, disappearance of organs, involutions.—Embryogenic function of puberty.

ANALYSIS of puberty by means of the phenomena of growth which it determines.—When the time of puberty approaches, growth modifies its rhythm in the divers segments. Plates I, II, III, IV, V, IX, X and XVI. The activity of increase is greater for some tissue, less for some other, none at all or retrogressive elsewhere. Certain organs appear at all points.

Augmented growth.—The child on becoming pubescent loses many of the elements which give elasticity to his movements; the elastic fibers lose elasticity, and there are some fibrous elements whose multiplication enlarges the ligaments and the tendons, and thickens the aponeuroses.

The connective tissue of which the fibrous elements are constituted also form numerous other organs, even some cellules with the function of secretion. It constitutes the balustrades, the partitions, the systems of support of the viscera. It forms the meninges (duramater and piamater), it forms the serous membranes, those of articulation as those of the great cavities, the arachnoid which clothes

the brain, as the pleura which covers the lungs and the peritoneum of the intestines. The connective tissue under its divers aspects is the seat of augmentation of breadth and thickness, of appreciable physiological hypertrophy.

The long bones have, above all, elongated since birth, the connective cartilage enjoying superior activity which characterizes cartilaginous growth during this period. From now on, they are to grow stouter;[1] this increase in thickness will be due to the osteogenetic activity of the periosteum which, in its character of original connective tissue, has benefited by the general connective hypertrophy, and has received in abundance of the formative elements of which it was moderately provided up to this time.

The muscles of the limbs, of the trunk, of the neck, of the face, and of the skull, augment in the semester of the appearance of puberty more than they had augmented in the semester preceding. The striated muscles of the heart take on, by successive steps, greater thickness, and the entire organ greater volume. Frequent, periodic ausculation reveals in many children the alternation of this increase which is in correlation, moreover, with the increase of blood pressure. The diaphragm gains in strength by the hypertrophy of its double muscular and connective element as the accrued amplification of the abdominal respiratory movements prove. The smooth muscles of the walls of the blood-vessels are notably strengthened as are those of the walls of the digestive tube, and particularly those of the intestines.

The external genital organs show only very little change at the début of puberty. The authors who describe the notable development of these organs and complete it by a series of attributes which directly make adult organs of

[1] This development is delayed for the tibia and the fibula Plate X, D.

them quite certainly have not been able to determine the period of puberty which they were observing.

This determination is, in fact, we know, quite impossible when the identical children are not examined at intervals of six months. For him who, on the contrary, proceeds in this fashion, puberty shows itself much less in haste to transform the external genital organs; it takes a year for it, often more and at least six months.

The testicles, in absence of volume, take on immediately a little more firmness. It is probable that the prostate, Cooper's glands and the seminal vesicles will grow in proportion to the requirements which the activity of the function of reproduction will impose upon them. But exactly in consequence of the functional correlations which connect them, it is logical to expect this hypertrophy of the sexual glands only at the time when the genital organs themselves give evidence of a sufficient functional maturity.

Reduced or arrested growth.—The skin is in this state; its epidermal layer is renewed in thickness, but it augments only feebly and slowly in extent. In observing the same non-pubescent subject semi-annually, one remarks, on some prescribed points around the articulation of the knee, for example, that the tegument is relaxed, easy to pinch between the fingers and to raise within a certain limit. At the following examination, when the augmentation of weight corresponds to a normal increase, without addition of adipose tissue, at the same spot the skin is seen to be stretched, more or less difficult to pinch, but quite removed in any event from the looseness noted in the preceding semester. This is an effect of alternation in the growth of the skin.

When, in this subject, the time of dawn of puberty comes, it occurs that the tension of the skin, and the condition is more obvious above the knees than elsewhere, is still more

increased. It is, without doubt, that the lower limbs are enormously and suddenly elongated; that can proceed to the point of rupture of the elastic elements (Troisier and Ménétrier) of the skin, a rupture which takes place following one or several transversal lines above the knee-pan, and leaves behind one or several white bands called "vergetures de croissance." [2]

There is the same reduction of development for the nervous tissue whose noble element approaches, at the time of puberty, the limit of its increase while the connective element, which surrounds and penetrates it, benefits more or less by the general connective hypertrophy.

The brain, according to the tables of Vierordt and of Boyd, attains its greatest average weight between fifteen and sixteen years. Vierordt [3] finds at twenty-one years (average adult age of those who reached puberty at the average age of fifteen and one-half years) that the average weight of the brain does not exceed 1412 grams, while it reaches 1490 grams at fifteen years in the male. In the female, the same author finds the maximum 1345 grams at fourteen years and only 1228 grams at twenty years.

The statistics of Boyd (1861) cited by Manouvrier in his article "Morphologie générale du cerveau" of the *Dictionnaire de physiologie* by Charles Richet, gives: from twenty to thirty years, 1357 grams, and from fourteen to twenty years, 1374 grams in man. For adult woman he gives 1238 grams, while the girl from fifteen to twenty years reaches 1244 grams (brain weight).

From these two sets of statistics it evidently follows that the maximum weight of the brain is attained at the moment of puberty. The tables of Vierordt are still more

[2] Rays arising from the distension of the skin in growth.—Trl.
[3] "Daten und Tabellen."

categoric than those of Boyd because they fix the age and show better the decline of the weight of the brain beyond puberty. Postpubescent reduction of increase of nervous tissue affects the peripheral nerves like the central nerves.

Total growth. Appearance of organs.—The hairs of the pubis and of the arm-pits spring up at all points. Their emergence, at the surface of the skin of these two prescribed regions, and that in both sexes, caused it to be used as a sign of the approach, then of the dawn of puberty.

The first hairs which range over the surface of the body are downy hairs, hairs lacking in marrow and supplied with large sebaceous glands. At a given time, these hairs fall, and the shoots of the permanent ones begin, the latter with pith, hairs of the same sort as those which will later appear on the face.

Thinly-scattered at first, they merit the notation P^1, then successively P^2 and P^3, on the pubis where they are first seen. We know that it is at this moment that the hairs of the arm-pits appear, A^1, while the change of voice, another phenomenon of growth, was realized when P had reached P^2. We have also seen that the hair does not always appear at the same time in both arm-pits, a difference which will always be noted by reason of its possible correlation with the state of the lung corresponding to the retarded arm-pit. I have met a few cases of pulmonary tuberculosis in boys who had presented this phenomenon, the tubercular lung corresponding first to the tardy shoot.

. . . . . .

Another example of total growth is given by the thyroid gland, where are organized, around vessels, a veritable network of lymphatic vessels which are substituted for the blood vessels in their rôle of channels of excretion of colloidal

substance. This fact, whose physiological interpretation remains quite obscure, is construed by a new activity of the thyroidal function and by various organic phenomena which appear to be attached to it.

This suffices in order that the educator may remember that the thyroid gland enters into a new phase of its organic rôle, dating from the dawn of puberty, and that he will do well to follow its variations in volume, with a view to pointing them out to the physician, if such should be the case.

Disappearance of organs. Involutions.—It is one thing to consider some phenomena of this order as some coincidences with those which precede and with puberty itself, another thing to join them to a common cause and to show that the objective, is indeed always, although indirectly, the convergence of all the organic resources towards the realization of the function of reproduction.

The evolution of the thymus is a witness of this in an interesting fashion. Observation on animals has demonstrated to me, in fact, that the volume of the thymus and that of the testicle are inversely proportional during the immature phase, and the same condition holds in man before puberty, as I have been able to verify in subjects whose thymus possessed a cervical lobe appreciable to the touch.

That gives meaning to the retrogression of the thymus and explains in a certain measure the rôle of the lympho-epithelial body, its relation with chondroblastic activity, with the richness in myeloplax of the marrow of the bones; and it is explained somewhat that the thymus recedes at the moment when the dawn of the function of the testicle is effected, at which time the character and influence of the interstitial cellules are recognized, at the moment when there is produced in the thyroid gland, a transformation

incontestably favorable to the rôle which it appears called upon to play henceforth.

The thymus is vascularized before the third month (Prenant). It enters into function from this time. The beginning of its retrogression has been fixed at the age of two years. That is individual. But, in general, its volume diminishes and the fatty degeneration of certain of its elements is effected in proportion as the volume and firmness of the testicle increase, in order to perfect itself about the time at which the germen terminates its evolution.

The group of lymphoid organs called amygdalae, "enclosed follicles," undergoes a similar regression although slower, and not appearing to depend to the same degree on the development of the testicle, but perhaps, rather on that of the paraganglion. Certain facts of observation lead me to believe as much.

In these amygdalae, spread to every portion of the digestive tract, but which appear more voluminous at the level of the superior portion of the pharynx, the stifling is designed by the interfollicular connective tissue which becomes more and more fibrous, by the closed follicles which they enclose, and where, from then on, fatty degeneration begins.

Embryogenic function of puberty.—By these phenomena of total growth, of augmented growth, puberty causes an embryogenic power to be manifested.

Not included in puberty, is a phenomenon of appearance of organs, that of the coming of the teeth, which would appear to prove that the embryogenic power, in the course of post-foetal ontogeny, is not the peculiar property of puberty.

This would, however, be a false interpretation of the development of the teeth, which is a continuous phenomenon

from the second month of interuterine life, up to the adult age, but of which we judge only at the time when the mucous membrane of the gums is cut.

A very remarkable thing, the dental evolution presents three phases like the evolution of the variations presented by the proportions of length and breadth of the body, and the three phases of those two developments blend absolutely. In other words, the phases of dental evolution are added to the phases of the evolution of the proportions in order to characterize the periods, the ages of evolution, such as we have delimited them (see p. 50).

The first phase: from birth to six years and first dentition;

The second phase: from six or seven years to fifteen years and second dentition;

The third phase: from fifteen years to adult age and close of dentition; that is, the four second molars and the four third when these latter, which are called "wisdom teeth," do not remain imprisoned in their alvéolar processes.

Dental evolution is then indeed a reflection of the general evolution of the soma (Professor Baumel) with which it shares the progress of growth, conformable to the laws laid down by Magitot.[4] The period of puberty answers to its last phase, as for the soma, and it is to that to which its action is limited.

But it is another category of phenomena which are really an effect and a proof of the embryogenic character of the influence of puberty. I mean the irregular growth, which results from the different nature of the tissues which enter into the constitution of an organ and the different activity of growth of which they are the seat. In other words, in a like organ, the play of augmented growths, of reduced

[4] "Dict. encyclopédique des Sciences médicales," 1re série, tome XXVII.

growths and of arrested growths, creates some inequalities of the kind of those which have been observed in the first hours of life.

In the embryo, these irregularities of growth had for end the building of organs. Today, since the organs are formed the end of irregular growth can only be to perfect them, to render their function easier and more in harmony with the new needs of the henceforth pubescent human being.

In the whole normal organism, irregular growth is governed in puberty by the law of alternation. When the organic equilibrium is disturbed irregular growth can escape the law of alternation and determine the pathologic condition.

CHAPTER VII

PUBERTY (CONTINUED)

Influence of alimentation by the placenta; precocious puberty, delayed puberty.—Some somatic conditions of psychological puberty—an example.—Separation of pubescents from non-pubescents.

INFLUENCE of alimentation by the placenta.—The placenta transmits to the child some elements of nutrition modified, without doubt, by the special work which the material blood undergoes in that organ but not endowed by what is absent in it. Let the mother, anæmic, pale and feeble, a townswoman nervously engaged in the cycle of city occupations, deprived besides of all the conditions of space, air, light, and physical activity which cause life to thrill to the very finger-tips and to the roots of the hair; let the mother, in short, without being positively ill, be the opposite of a vigorous woman, then, placental nutrition of the child will have all the chances of being bad. It is the same, moreover, in the case where a woman well built and of usual fine health commits imprudence on imprudence from conception on; in the case where, during the course of pregnancy, pleasures and sports occupy her life; wedding tour, mountain trips, skiing, motorcars, rough voyages, etc. . . . An infectious malady of the mother during the evolution of the embryo-foetus has very often the same effects; the latter can, besides, be very easily provoked by a simple fall in the course of pregnancy. Bad nutrition by the placenta can have a

great many mediate and immediate effects and can be singularly reënforced by the nature of the alimentation after birth.

Precocious puberty; delayed puberty.—But a remote effect is what one could almost count upon. This is the retardation of puberty. There is nothing about it which ought to surprise us. Do we not know that this embryofoetal period is that of the constituting of the seminal and somatic progeny, that, on their nutrition at this moment depends the speed of their evolution, and that, from the constitution of the placenta, the germen finds itself under the nutritive dependence of the soma? That suffices in order to understand that a poor placental nutrition can determine a delayed puberty, and that precocious puberty may be the result of a good inter-uterine alimentation.

One rarely finds two brothers who reach their puberty at the same age. That fact has not at all passed unperceived by the physician who has been enabled to witness the birth and follow, until beyond puberty, the two male products of a twin-pregnancy.

I do not except the twins called "identical," for that identity does not resist the physiological and clinical observation completed by anthropometrical examination by which the anatomical conditions are determined. I do not except them for these differences which one has a tendency to consider as reserved to some twins of different sexes, in matter of physical extra-genital quality, as in matter of proportions of the diverse segments of the body, exist quite as well, with some very rare exceptions, in twins of the same sex called identical.

The cases of twin brothers, becoming pubescent at different ages and having been reared under the same roof, are sufficiently numerous to lessen notably the influence at-

tributed to race, to heredity, to climate on the advance or retardation of the time of puberty. Garn. Adr. reached puberty at 14 years; Garn. Eug., his twin brother, reached his at 17 years. Among boys whom I have followed like these from the age of thirteen years to the age of eighteen years, I could cite some other examples and I have equally noted some in families.

Cases of brothers, not twins, but of the same father and mother, who have grown up side by side and have received the same alimentation during the first year of their existence, testify in the same direction.

Now, of two twins, that one who will be developed the last, is precisely the one who, at birth, was the least nourished. This defective inter-uterine nutrition re-echoes, we know, on puberty in a twofold way. The germen has been indifferently nourished at the very period of the constituting of the seminal offspring and this is the chief point. Besides, the somatic offspring, at the moment of its constitution, has suffered also from that defective nutrition of which the nutritive contributions of the soma to the cellules of Sertolli will not cease to feel the effects. That indirect influence will be added, for the seminal offspring, to the influence which is directly exercised upon it, and the necessary consequence is the retardation of its maturing.

Such are the various physiological reasons which lead to attributing to placental alimentation the preponderate influence on the age of the appearance of puberty.

Some influences, of pathological order, extra as well as inter-uterine, are also sometimes exercised, and show themselves capable at various times of reënforcing or lessening that primordial cause: such is the influence of a tumor of the testicle which can provoke, as early as the age of nine and one-half years, puberty with its physical and moral

attributes, puberty which disappears with the tumor and leaves no trace four months after removal of the latter with the testicle affected. All hair from the pubis and armpits have fallen and the voice itself has again become a child's voice (case of Dr. Sacchi, reported by Marro).

This fact shows clearly that the germen is cause of the determination of puberty. It also shows the embryonic character of the phenomena of puberty provoked by the germen.

Among the troubles due to the presence of the tumor and its development, a notable nutritive superactivity necessarily figured. It may be that this was the gain of that local superactivity which had procured to the germen the precocious power of which it gave proof. A microscopic examination would doubtless have caused a recognition of the presence of spermatozoa in the ducts of this neoplastic testicle.

Puberty is then a purely germinal affair and the maturity of the germen itself an affair of nutrition.

The observations of Dr. Gandy prove, on their side, that for the maintenance of the attributes with which puberty has endowed the soma, it is necessary that the germen subsist. In the case of Dr. Sacchi, the suppression of the accidentally mature germen of the neoplastic testicle carried along with it the disappearance of all the signs of reproductive power prematurely appeared, but did not influence at all the natural evolution of the boy toward his normal puberty, because there remained with the other testicle, a sound germen; while the total suppression of the germen at some moment of the virile period exposes to a turn backwards, to a reversion, that is, to the loss of the secondary sexual characteristics which had accompanied puberty.

The presence or the absence of these characteristics de-

termines some profoundly different conditions. These pathological cases demonstrate it in a striking fashion by reason of the ages at which the changes happen, and because they appear without transition. But, under the reserve of transitions, it does not occur otherwise for well children and the difference is complete between a child who has not reached puberty and a pubescent child, boy or girl.

Some somatic conditions of psychological puberty,—an example.—Some years ago two brothers accompanied by their parents presented themselves at my Tuesday consultations. Both were seventeen years old; they were twins. The family was perplexed. The career of diplomat opened itself exceptionally for both, but only one of the two showed what one might call aptitude for the career. Besides, the differences between the two brothers were many and profound. That did not escape the father and mother who were greatly disturbed by it. Of those two boys, seventeen years old, the one bore himself like a man, the other like a young vagabond, and that in everything.

At twelve years, said the father, his son George had already almost lost childish habits which were observed in James at seventeen years. They had had him carefully examined, but it was certified to them that his constitution was good, and that his mental state had nothing abnormal. His professors recognized in him real intelligence and a quick memory, but they complained of his extreme thoughtlessness.

The young men having stripped, a thing which had not been done at the preceding visits to the physician, the parents told me, it was evident for the father as for me that George was pubescent and James was not. In George puberty had been reached at about the age of twelve years. That was five years ago. George was now an adult, while

James, of the same age and size was still only a child. George was nubile, James was not yet pubescent.

I was in the presence of two individuals of the same age, and yet the one was a man, and the other was not even a young man (jeune homme). They were of equal stature and their weights were very nearly the same, as was their chest girth. What combination of these three measures was capable of giving information on the physical value of these boys? They withstood in a very unequal manner an exertion a trifle prolonged; not only did the adult show a resistance far superior, but he was able, after a short rest, to resume the interrupted work, a thing which his twin brother could not do, who needed to prolong the period of rest in order to rest his legs, his arms, and to recover his energy.

The three measures, height, girth and weight had taught us nothing regarding these two young men, not more concerning their physical worth than concerning the causes of the profound differences which held between them. Puberty by itself, had already made us better acquainted with them and had furnished us some instructions on the divergencies of their two individualities.

The anthropometric, physiological, and clinical examination showed us that the proportions in James were still prepubescent proportions, that is, that they answered to the intersegmentary relations which are met with in children who touch the period of puberty. I thought that puberty would arrive normally, in spite of its delay, by reason of the regular conditions of the general state, and of the partial evolutions, on the part of the testicles, and of the teeth, etc. The cranium was proportionally small, even for a macroskele like James, the limbs were too long, relatively to

the bust, a relation which of course is proper on the eve of puberty.

I was able to say nothing of the dangers of the unequal growth, because I had not followed these young boys since the age of eight or ten years from semester to semester, and because the evaluations, in this order of ideas, are only the result of comparison among themselves of the dimensions of a like segment at the successive semesters.

The muscles were average, and respiration had retained the amplitude of that of childhood; it was more transversal than vertical, while in the twin brother it was more vertical than transversal, which is an adult characteristic.

I could, with good conscience, reassure the parents and make them foresee a transformation shortly, a germinal transformation with its somatic and cerebral consequences, without, however, determining precisely its range from the point of view of organic resources and of energy, because I had not followed the boy since a number of semesters before.

Before the time of the appearance of puberty it was necessary to be careful to make a decision relative to his [James's] future and not despair at all. And in fact, puberty did not delay in arriving and changing the boy into a man in every way.

The orientation of ideas of this big boy, incontestibly intelligent, had been strongly influenced by the contacts which his age and size had imposed on him, with his pubescent comrades. He had lived their life, he had wished to do as they did, he who had not reached the same phase of evolution and did not yet possess the genital, physical, and mental attributes with which his comrades and even his twin brother were already endowed. The objective harmonization, the effort of action had found themselves fatally in

contradiction with the resources, with the possibilities of this non-pubescent.

Separation of pubescents and non-pubescents.—From like circumstances there arises an evil which has, for appreciable effect, instability. You conceive the danger to which a child is exposed who is placed in the midst of children possessing attributes which he himself does not possess. What vain efforts that provokes in him; what mental disorder follows; what tendencies that develops to seek outside himself or in reverie what he is not able to realize with the means at his disposal, and that towards which, nevertheless, he is driven by the examples about him and by the need of raising himself up to those who affect, in his regard, some attractions of superiority which he has hastened to imitate in order to suffer no more from it.

This example, which I emphasize in passing, indicates to you already in what sense psychological puberty is more complex or perhaps more simple than it has been described and shows to your cautioned sagacity glimpses of the conditions which observation exacts in order to see and understand thoroughly.

Pedagogically, there is in every case one conclusion which is imposed; that is the separation of the pubescents from the non-pubescents. Intellectual culture as well as moral is interested in this separation.

Beyond the kindergarten, continue to keep together, if you desire, girls and boys. But, by a close co-operation with the physician and enlightened yourself by the secondary signs, watch carefully for the appearance of puberty. As soon as it appears in a schoolboy or schoolgirl promote this modified organism into the category of pubescents; do not take account of the age. Neither see any obstacle in the multiplication of courses. The administrative author-

ity, having been notified, will take the measures necessary to render your task possible in the interests of the little individualities which it confides to you.

But, you say, pubescent and non-pubescent brothers live together under the paternal roof. On this account, the same roof sheltering permanently girls and boys in the family circle, of what good are your distinct schools for each sex? It is because a special sentiment reigns at the fireside, which is born there and with a special charm, it is the sentiment of protection owed to the small by the large, to the young by the older, to the feeble by the strong, to the girl by the boy. Outside of the family, do not count on it, while applying yourself with all your might to develop it or to nurture it, and do not hesitate to use, to this end, puberal selection. Its effects are incalculable.

The familiar imitation of family life of Bedales, of Abbotsholmes, in England, where the professor, his wife and their children group around them in an isolated dwelling some twenty scholars, is raised by a hundred cubits above the best boarding-schools. E. Demolins understood this point well when he founded "l'Ecole Nouvelle" although he was able only to approach that ideal. But a gulf remains between the mentality which presides in fraternal relations and that which presides in the relations of scholars among each other, even in the bosom of these family schools. Whence the necessity, there as elsewhere, of puberal selection.

CHAPTER VIII

PUBERTY (CONTINUED)

Duration of period of puberty; signs of début; signs of termination.—Internubilo-pubescent period or youth.—Distance from puberty to nubility or adult state.—Some educational considerations touching these periods.—Synthesis of the relations of the reproductive element and growth; phases of life in function of reproduction.—Influence on growth of the traumatic suppression of the germen.

IT is not imagined by people in general and often not even by us, educators or physicians, what past a retardation of the "formation" reveals, and what future it prepares for. There results from it a complete ignorance of the duties which it imposes, such as the preparation for puberty, preparation for the post-puberal phase, the utilization of the "educative moments" of the diverse organs for general or special physical or intellectual culture.

Where then can the educator get information of the exact place which puberty occupies in the evolution of the child? Where can he find notions relative to its duration, to the distance which separates it from the adult age? There is in the study of this subject, however, some information which is far from being indifferent to the direction of education, because it concerns the very conditions of the influence of puberty. But growth had not yet been studied at all from this point of view although one could expect only

from it precise information on these important questions. Now the age of taking possession of the organism by puberty varies with each individual. The principle cause, we have learned, is the quality of placental nutrition.

Duration of period of puberty; signs of début; signs of termination.—As to the time which puberty takes to install itself, it is the same in all normal children almost, say two years. At the moment of appearance, one has noted down for the growth of the hair of the pubis and of the armpits, P^3 A^1. On following the same child one notes later P^4 A^1, then P^4 A^2, finally P^5 A^3, or A^4, or A^5. At this last notation, P^5 A^5 (A^3 or A^4) the installation of puberty is an accomplished fact. Two years have passed since the appearance, and if the child was then fifteen and one-half years old, he is now seventeen and one-half. During these two years, growth has progressed in a somewhat special manner under the influence of the new impulsion which the soma has just received from the germen. The rate of increase in height is a trifle lessened, and the child has commenced to fill out, to augment his dimensions of breadth and thickness; his muscles have become stouter, the truncal segment of the bust, the trunk, where are grouped the transforming and distributing visceral organs, has gained in amplitude and its capacity, which is proportionally reduced since birth, has commenced to take up more room in the organism. From now on, the trunk will not cease to gain in extent until the end of the time of growth (v. "Laws of Growth," pp. 109 and 116).

Internubilo-puberal period or youth; distance from puberty to nubility.—Immediately after the closing of the puberal phase, growth undergoes a very notable slackening, and it is so much the more obvious that it follows closely the augmentations which characterize puberty, the

first year of its evolution especially. Plates I, II, IV, V, XV and XVI.

There is a reduction of the rate of increase but the organism continues, however, to grow in all directions: all the dimensions could figure in a table intended to make the augmentations of the internubilo-puberal period stand out; but they would also appear with the very unequal reductions which have attended their growth, causing to be presented the changes which result from it in the proportions of the body.

A few measurements answering to the principal dimensions of the body are to be compared to the same measurements taken from the adult, and make thoroughly comprehensive the difference between the state of the child at the end of the puberal period and his adult state. These data are grouped in the following short table:

	Average child at the close of his puberty	Average adult	difference
Weight (stripped)	56	64	8 kilos
Breadth (transversal chest dia.)	258	269	11 mm.
Thickness (anterior-posterior chest dia.)	191	199	8 "
Girth (max. thigh girth)	481	506	25 "
Height (stature)	1636	1659	23 "

At an epoch of life when the adipose tissue, the fat, still holds only a negligible place, in the great majority, these 8 kilos to be acquired represent an important amplification of the tissues; the elongation of the stature not having to exceed 23 millimeters, that shows especially, the broad plasticity, that is, breadth, thickness, girth will gain in dimension.

Girth will augment 25 millimeters. The average child will then increase more in girth than he will grow in height during this period and that, without appreciable participa-

tion of adipose tissue. Embracing the entire period of boyhood, it is seen that the average child between thirteen and one-half years and the adult age, increases his weight by 27 kilos, his breadth by 51 mm., his thickness by 40, his girth by 96 and the length of his upper limbs by a total of 115, while his stature increases 207 millimeters.

If one compares to this growth in volume, considered in each category as equal to 100, each of the annual increases of this same period, one will account for the proportional part of increase which remains to be realized beyond seventeen and one-half years. This table, which is interesting, but offers a certain complexity, can be reduced to the following approximate fractions, which renders its reading easy.

Having admitted that, from thirteen and one-half years to adult age, the growth of the child had to gain, in each of the directions considered, a certain number of millimeters, and that, in each of these directions, we evaluate at 100 this total gain, how many per cent has the young man of seventeen years to acquire in order to be an adult?

The pubescent lad of seventeen years, in order to become an adult must gain:

Weight	29% or ⅓	approx.
Breadth	21% or ⅕	"
Thickness	20% or ⅕	"
Girth	26% or ¼	"
Height	11% or $^1/_{10}$	"
Length of upper limbs	23% or ¼	"

From the close of puberty to adult age, weight has more to acquire than it has done in the course of the most active year between thirteen and eighteen years. It is wholly different with height whose proportional part of growth to be furnished is less than that of any one of prepuberal and puberal years. As to the other dimensions, they have to

furnish only the proportional increase of a good average year, and they have three years to accomplish that. In effect, on taking account of the progressive reduction of the rate of growth, one comes to evaluate at three years, the time necessary to the completion of the development of the average young man, that is, five years from the dawn of puberty. Thus the pubescent boy (15½ years) would become an adult at twenty-one years (twenty and one-half years). That is admissible, for, in the regiment, it is exceptional to observe any important increases in size, excluding the volunteer recruits of eighteen to nineteen years. I have become convinced of this, in measuring a great number of soldiers on their arrival at the corps and on the eve of their discharge.

In its turn, the soma has completed its development. It is here in condition to give perfect co-operation to the germen, in view of reproduction; nubility is accomplished, physiologically speaking.

It is the duty of educators to distinguish biological and social nubility: "biological nubility, so understood, is only the fitness for marriage considered solely from the biological point of view. From the sociological and moral point of view, marriage implies some conditions and a maturity which render the question of nubility much more complex (Manouvrier)."

Thus, then, puberty takes two years to install itself. The perfecting of the soma, or the internubilo-puberal period lasts three years; it is then a period of five years from the moment of appearance of puberty, from P^3 A^1, which is required for a young boy to become a nubile man, an adult, a reproducer as perfect as his individual condition will permit him to be.

When you know that the notation P^3 A^1 is recorded on

the individual record card of your son, you know, parents, that in five years he will be nubile. If he is fifteen and one-half years old when P^3 A^1 is recorded, at twenty and one-half years he will be nubile; if he reaches P^3 A^1 at seventeen years only, he will reach his nubility at twenty-two years. When, on the contrary, puberty dawns at twelve years, your son will be an adult at seventeen years.

And if you will kindly remember that there is a matter other than a question of physical development, a matter other than a purely somatic growth, you will recognize that this question has a claim to your most diligent attention.

Out of these five years, stretching from the dawn of puberty to the realization of nubility, the last three especially, correspond to the phase to which more than any other, the name youth agrees. The pubescent boy has become a youth (jeune homme).

In the feminine sex, according to the authors and my observations, the distance which separates puberty from nubility can likewise be estimated at five years, and it can be considered that the little girl becomes a girl ("jeune fille") two years after the dawn of puberty. Five years after the appearance of the first menses, the girl is nubile; she is a woman.

Some educational considerations touching these periods. —Young people are morally and cerebrally, on the morrow after puberty, what the struggle which takes place within them, makes them. In animals, most often, the internubilo-puberal period does not exist. When the animal is "mature" he is at once pubescent and nubile. There are, however, some exceptions.

The phase of youth ought to be the triumph of education; it can be the failure of it. It is necessary that the preparation of education should have been such that, in the young

man, everything tends to perfect his individual resources in the precise direction of the position which he wishes to occupy in society, while his soma itself completes the perfection which a reproductive function useful to the race exacts. "Youth" pronounces judgment on the education of the child. It is the cross-road where temperament, education and life meet. It depends in great part on education whether youth be knocked about and onerous or made harmonious and pleasant.

Synthesis of the relations of the reproductive element and growth.—The puberal phase is, as we have just seen, a time of human development in which the germinal power orientates all the forces of the organism towards the function of reproduction. It had impressed a first general impulse from the time of the *egg*. Twelve or fifteen years later, it gives a second more special impulse. The soma is constituted and the objective is approached, but the impulse is analagous.

In reality, the evolution of the reproductive function holds under its dependence the entire life of the soma. It imposes upon it (the soma) its natural phases by the setting which it gives these phases.

On page 103 is a table of it, the relations of the phases of life with the function of reproduction, in which it is seen that to each of the periods of evolution of the germen corresponds a period so strongly characteristic of life that it is impossible to represent it to one's self otherwise delimited.

Growth has made us acquainted with the effects of the puberal impulse stamped upon the soma by the germen. It has shown us what the soma had to pass over in order to realize the best conditions of which it might be capable in its rôle of agent of the function of reproduction.

Influence upon growth of the traumatic suppression of the germen (*eunuch*).—We should be interested in knowing what occurs, how the soma behaves when the germen disappears before the puberal age, and what, consequently, puberty does not do.

We see the result in the eunuch, and particularly in those *Skoptzy*, coachmen, of whom Pittard speaks in his important studies on the anthropometric modifications effected by castration (*Modifications anthropométriques apportées par las castration. Bulletin de la Société des Sciences de Bucharest*, nos. 3-4; 1903).— ". . . Others go to Jassy or to Bucharest to follow the calling of coachmen . . . ; they are recognized very easily by their bloated, smooth face, by their woman's voice. . . . When they are seated on the box of their carriage, one can only with difficulty imagine their stature. It is because their stature is made up principally of the exaggerated length of the legs. At several returns," continues Dr. Pittard, "we have received the hospitality of the *Skoptzy*, either in 1901 or in 1902, hospitality, moreover, limited to a few meals taken while we were examining them. We had been struck by the tall stature of the most of them, by their smooth, fresh face, their feminine voice, the softness of their skin which at the same time presented an aspect of freshness, of youthfulness, and of suppleness. Nearly all wore long, straight, dark hair, falling in locks down over the countenance. In order to honor us, they had done their hair over with pomade or oil. Their hands were delicate, tapering, and supple, like the hands of a woman" (*loc. cit.*, p. 182, 183).

Here were some adults who presented in an exaggerated fashion, the proportions of a child on the eve of puberty; seated they had the aspect of children by the slight height of the part of their body which rises above the seat, as well

as by their visage of which Pittard emphasized the appearance, fresh ("poupine"). Erect, they were adults, at least in stature. From infancy, the soma appeared to be modified only by the elongation of the limbs; the aspect of the visage, the absolute length of the trunk, the condition of the skin had not changed.

Pittard emphasizes the inferiority of the volume of the brain in these men, of Russian (Petits Russiens) descent, compared to the volume of the brain of their kindred, not emasculated. The action of the germen, its influence upon growth is then demonstrated to us by the modifications which this action undergoes in its absence. If, with numerous modern authors, one attributes the elongation of the bones, to hypophysis, the hyperactivity of this gland to internal secretion, manifesting itself in the eunuch only after castration, will itself represent an effect of the suppression of the germen. Besides, one will be able to determine with precision the results of the prepuberal suppression of the germen only in subjects emasculated before the age of twelve years, and better before the age of six years, the end of the first period of post-foetal evolution, then followed from semester to semester with all the resources of the auxanological method.

The observations and experimentations on animals with which I have occupied myself a long time in accordance with the counsels which Professor Milne-Edwards had very kindly given me in 1896, have furnished me some interesting results, but they are applicable to the human species only with great reservation.

PHASES OF LIFE

IN FUNCTION OF THE REPRODUCTIVE ELEMENT

the germen

issue of reproduction.

Period constitutive of the elements of *seminal offspring*	EMBRYO-FOETAL PHASE
The *seminal offspring* finishes its constitution and vegetates (birth).	
Agenital life, sleep of the germen. The seminal offspring completes its evolution, *awakening of the germen:*	INFANCY [1]
PUBERTY	
Internubilo-puberal period. The mature *germen* awaits the maturity of the soma. Maturing of the somatic factor of reproduction. *Nubility.*	YOUTH
Fulness of reproductive function	ADULT PHASE
Extinction of *seminal offspring*	
Agerminal life	OLD AGE

Continuity
of the life of the
germen by the descendant.

[1] The term adolescence is admitted to designate the last phase of infancy, the peri-puberal phase.

CHAPTER IX

SOME LAWS OF GROWTH

Laws and method.—Make-up of the laws of growth.—Law of alternation.—Laws of puberty.—Laws of proportion.—Principle of irregular puberal growth.—Résumé and formulas of the laws of growth.

THE laws and the method in matter of growth.—Buffon had formulated a general law of growth in length which all observations since have confirmed. "There is something quite remarkable in the growth of the human body," he wrote; "the foetus in the mother's womb grows constantly more and more until the moment of birth; the child, on the contrary, grows constantly less and less until the age of puberty."

The law of Buffon is one of the rare ones which, only considering the height, is applicable to the development of the whole body. That is due to its very generality. Some other authors have treated the very notable elongation which precedes puberty; but they do not fix the moment of the appearance of puberty.

The sexual differences of growth of height have given place to some divergence of opinion, such that it is no longer permissible to formulate any general rule as to the rhythm of elongation. That is not much to be regretted, the height being considered alone. That was, however, to be foreseen, and it will be so, as long as the simultaneous, hasty method will be substituted for the scientific method, so long as the

observer will not take the time and the pains to follow the same children and to take on each of them all the useful measurements and notations patiently repeated at each semester.

Let us recall that, for want of using this method and in taking the stature as the criterion of growth, should the measurement of height be accompanied by that of chest girth and weight, one is infallibly led to this conclusion at least strange, that among the finest specimens of which human kind can pride itself, the eunuch occupies a place of honor.

Eunuchs of 180 cm. are not rare, their habitual embonpoint assures them large figures for chest girth and weight. So that in a table where height, girth and weight in view of an appreciation of physical value, and whatever other combinations imagined by means of these three numerical expressions, might be recorded, the most of these infirm people would appear as excellent recruits.

. . . . . .

But, and this is serious, to what phenomena has the method of unique, simultaneous examination at the diverse ages, and reduced to some measurements, to what phenomena of the development of the being would it have helped us? What rhythm would it have enabled us to understand? What general rules would it have led us to formulate?

It belonged to the periodical and polymetric method, to what we have called the auxanological, in order to group around its object, growth, its physiological, clinical, and anthropometrical resources, it was reserved to the auxanological methods to make these observations, to disengage the rhythm of growth, to investigate the explanations of it and to infer some general rules from it. It belonged to this method to make the departure between true growth and

what has been too long considered as its expression, to determine a certain number of variations and to verify some of their causes.

Make-up of the laws of growth.—Be careful not to infer from this that the rhythms of growth are all semestral. However, when Buffon directed the measurements of M. Gueneau de Montbeillard, he had seen that the semester corresponds to a certain number of rhythms, and he caused others to see it.

The law of alternation.—And now, let us try to render ourselves an account of how the facts lead to a law of growth, taking, for example, the law of alternation. The multiple measurements, which are evidently laborious, procure at least some large scientific compensation. They permit, for each half-year, the reconstituting of the segments with their absolute dimensions. In calculating their relations to each other, one can establish their relative dimensions, and know on which segment of the bust or the limbs, the process of growth has borne with the greatest activity, in the course of the semester at the end of which the child is measured. This is applied to increases in thickness and breadth as to increases in length.

Segmental growth corresponds to the increase of a small group of bones, and, for the segments of limbs, to that of a long isolated bone, like the thigh or arm, or to that of two long twin bones as the leg and the forearm. The elongation of one of these segments represents, consequently, the elongation of the corresponding long bone, of the femur or of the tibia and fibula, of the humerus or of the radius and ulna.

In the vicinity of the ankle or wrist, the muscles are reduced to their tendons, very often bound in the grooves of the bones. At this point, the thickness measured is a thick-

ness of bone, relative to the muscular thickness which represents the maximal circumference of the segment.

I compared, in 1897, the changes which had taken place in the segments of limbs of the children of "l'Ecole des Andelys," measured during seven semesters with those of which the homologous segments had been the basis in the pupils of "l'Ecole de St-Hyppolyte-du-Fort," seeking to determine the influence of the very different climate of these two localities.

I believed at first I would have to consider erroneous the first results of the calculations which showed the growth in bulk at another semester than the elongation, or at least, which made the minima of the elongation correspond to the maxima of increase in bulk. Presently the precision which this fact took by the side of the bones of the leg and of the forearm, throughout the comparison of the results of the same order in the two schools, showed me that there was no error nor exception there, and that the increase in bulk was effected with activity only when the activity of elongation had slackened.

I noted carefully this observation without attaching to it at the time any general import. In 1900 I worked up the part of my researches destined to the making-up of my work on the growth of the diverse parts of the body in the average child. The individual repetition of the same relations and the striking comparisons of the semestral increases in length and thickness of a like segment of the average child, imposed themselves upon me with the validity of a principle, namely, the elongation and increase in thickness are not simultaneous, but alternative.

The average adolescent put thus in relief the opposing rhythm of the elongation of two long consecutive bones; when the femur elongated the tibia grew in thickness, and

when the femur grew in thickness, the tibia elongated. It was not a question of suppression of the elongation when the growth of thickness was taking place, but of a reduction of the rate of elongation and vice versa. The rhythm of this growth of bones was, besides, semestral.

One hundred children followed from semester to semester, of thirteen to eighteen years, contributed their measurements for the making up of the *average.* After them, one hundred-thirty others, followed in the same fashion, formed the reserve, the check to the circumstance.

Nothing in the facts gathered could be charged as fortuitous, and I was, without being able to doubt it, in the presence of a general rule. The result of the working up of my researches demonstrated to me the biological import of this law,[1] from which arose directly or indirectly the great majority of the phenomena of growth springing from the observation counted or noted down.

That fact led of itself to diverse formulas:

Lengthening of two consecutive long bones. The periods of activity and of rest which succeed each other at half-year intervals in the increase in length of a long bone are opposed for two consecutive long bones of a like limb.

Lengthening and thickening of a long bone. The rests and the elongation are utilized by the increase in thickness and vice versa. The long bone grows in thickness and elongates alternately and not simultaneously.

It is accepted that osseous growth is subject to alternations. The alternations with their irregularities are, for the development of the body, one of the characteristics of

[1] See on the subject of "The Law of Alternation," pages 107, 108, 111, 119, 120, 122, 123, 127, 128, 134, 175 and 176 of my *Recherches anthropométriques sur la croissance des diverses parties du corps,* 224 pp. Paris, Maloine, pub. 1902-1903.

biological progression, which they differentiate from the arithmetical progression of Quételet.

The alternations do not depend upon the seasons. The first law demonstrates, in fact, that the half-yearly periodicity does not imply any seasonal influence. With still more reason, the seasons do not have any influence on the alternations which escape this periodicity.

The alternations undergo a preponderant influence on the part of puberty.

The half-year represents the average duration of alternation of a great number of increases in growth. Puberty is the center around which the great alternations evolve.

Laws of puberty.—We have seen that the reproductive element, the germen, had a considerable influence on the effects of growth and that it has no equal except that influence which the germen exercises on the somatic offspring from the ovule.

At the present time, it is a question of the influence of the germen on the secondary causes of growth.

A certain number of laws of puberty are dependent upon the more general law of alternation.

Bust and lower limbs.—*Height owes the greatest part of its development before puberty, to the lower limbs, after puberty, to the bust.* Plate X, A.

This fact finds its explanation and its cause in the phenomena of augmented growth and of reduced growth which we have just carefully studied. We have seen, in fact, that puberty *favored* the auxanological activity of the connective tissues and *reduced*, on the contrary, the growth of *cartilaginous* tissues. The cartilaginous organs consequently offer an activity of growth much less and for some almost none, beginning with the period of puberty; the connective

cartilage undergoes like the others this puberal influence, and the elongation of the long bones which proceeds from it feels the effects of it directly. By the contrary, the organs which grow by the connective tissue, augment their dimensions. This is the case of the growth in thickness of the long bones which is secured by the periosteum. We are able to generalize these remarks and say:

The osteogenic periosteal activity of the cartilage, dominated by the osteogenic activity of the cartilage before puberty, prevails over it after puberty.

Whence this corollary is derived:

Elongation and increase in thickness of bones: *The progress of elongation of the bones excels before puberty; the progress of increase in thickness of the bones excels during and after puberty.*

How then is it possible not to foresee the puberal relations of increase of height and of weight which result logically from what precedes?

The principal peripuberal increases of height are produced during the three semesters which precede puberty; the principal peripuberal increases of weight take place during the three semesters which follow. Plate X, B.

Among the tissues whose rate of growth is augmented by the intervention of puberty, figures the muscular tissue. The contrast with the increase in length of the osseous tissue is clearly marked; and as the elongation is the most easily appreciable of the manifestation of growth of bones, one can express this fact in the terms which I used in 1902: *growth is above all osseous before puberty and above all muscular after it.* Plate X, C.

One of the total growths which the germen at the moment of perfection of the evolution of its offspring provokes, bears on the hair. The appearance of these organs,

destined to replace the down, precedes by a trifle the dawn of puberty itself. The hairs are multiplied during the course of the appearance of puberty, and until the puberal phase is completed or, at least, at this time, the hairs of the pubis and of the armpits have become as tufted as they are going to be, and, if the fleece continues to grow thicker, it is outside of these two regions.

Observation by the auxanological method has permitted of establishing the relations between the shoot of the hairs and the evolution of puberty; it has also permitted their formulation with precision.

Shoot of the hairs and puberty: *The début of the shoot of pubic hairs* P^1 *precedes by three semesters, on an average, the dawn of puberty* P^3 A^1.

In the two sexes, the début of the shoot of the hairs of the armpits corresponds almost exactly to the dawn of puberty.

Now, A^1 which expresses it, corresponds to P^3, so that this is one of the effects itself of puberty, namely, a total growth, which reveals it to the observer. It is not a question of coincidence but a relation of cause to effect, which explains the constancy of the relation between the phenomenon itself and its exterior manifestation.

The end of the shoot of the hairs, on the pubis and in the arm-pits, that is, the moment when the fleece, observed half-yearly, has attained its greatest degree of density, is noted by P^5 A^5 and that corresponds to the end of the establishing of puberty.

The end of puberty, its duration. P^5 A^5 *which marks the end of the puberal phase, survives four semesters* (*about two years*) after P^3 A^1.

The comparison which leads to the noting of the successive powers of P and of A, is made between the condition in the present semester and the condition in the preceding

semester of the pubic fleece or that of the arm-pit in the same child, which gives a relative value to it, but exclusively individual. The density of the hair answering to P^5 A^5 in a child, can represent only the value P^4 A^2 in another.

Consequently, as soon as one perceives the hair on the pubis, he can consider that the dawn of puberty will take place in three semesters, two years at the most. From the time when P^3 A^1 is noted in a boy, it is necessary to count about two years before he will have passed the puberal period and attained the notation P^5 A^5. And three years will have to elapse in order that the internubilo-puberal period terminate in nubility, and realize the conditions which constitute the adult state.

Whence this law:

Place of puberty in the evolution of growth. *Twelve to seventeen years separate puberty from birth. Two years suffice for puberty to establish itself, beyond which three years are necessary in order to attain to nubility.*

In consequence, puberty in its relations with the evolution of growth, shows no variation except in the time of its appearance. When puberty dawns, the child finds himself five years from his nubility, the condition of his adult state.

A girl who reaches puberty at seventeen is nubile, is marriageable only at twenty-two years. While another, her sister perhaps, in whom the appearance of puberty occurred at the age of twelve years, has already effected her nubility at seventeen years. The latter is already a woman when the other is still only a child. It is the same for the masculine sex as the case of the twin brothers has shown.

The difference is considerable between twelve and seventeen years, and these differences, especially in two sisters, are not explicable, unless the cause is acknowledged which

I indicated in a memorandum to the Academy of Science of November 13, 1911, and was considered above; I mean the quality of placental alimentation. We saw that the one of the two twin brothers best nourished in the palcenta, developed the first. It appears then that one were warranted in believing that: *Puberty is precocious or tardy according to the quality of alimentation by the placenta.*

The subsiding which is operative in the rate of growth in height from the semester which immediately precedes puberty, and which besides will only cause itself to be accentuated, has been interpreted by authors as a gathering itself up of the organism on the eve of the great effort which it is going to make. We are now prepared to interpret this fact physiologically and anatomically and to consider it as a case of the law of alternation, a case susceptible of being predicted by him who is informed on the influence of the germen upon the growth of the divers tissues, by him who knows that the articular cartilages like the others lose at this moment the major part of their activity of growth, and that, consequently, the long bones, either quite cease to grow in length, or indeed reduce considerably their growth in this direction. The reduction of the increase of stature has no other cause at this epoch.

Perhaps the term "gathering up" (recueillement) is not fitted to an organism whose most important part, the trunk as well as the neck, has no tendency to reduce its growth, and on the contrary, begins to grow (*grossir*) very actively.

It is a question of an alternation in the increases as one observes when he follows a child from semester to semester, certain increases of length giving place to others of the same direction, either to some increases in breadth or to some in thickness. However that may be, the organism remains too active to be a question of "gathering up." That shows once

more how little the stature represents the growth of the human organism, and to what errors of interpretation it can lead.

From all the foregoing we conclude: *The phase which immediately precedes puberty does not differ from other phases of growth in balanced children, and at this moment as at others, the organism takes only partial repose, conformably to the law of alternation.*

Changes of puberal coloration. *Hair.* Puberty renders the coloration of the hair darker in 28 cases out of 100. *Skin.* Puberty causes the appearance of a brown pigment on the skin of the perigenital parts of the body in 30 cases out of 100. *Eyes.* 63 cases out of 100 modify the color of the eyes (coloration of the pigment of the iris) at the moment of puberty; in 18 cases out of 100 it becomes darker; in 45 cases out of 100 it becomes lighter.

Laws of proportions.—This question was taken up already in Chapter III, and we shall have for use the study of the proportions at the time of the making up of the "individual formula." We here again find the dominating influence of alternation and that of puberty.

There are three phases in the evolution of the variations presented by the proportions of length and of breadth of body. The first from birth to six years; the second from six to fifteen years; the third from fifteen years to adult age. Plates I and V.

If the proportional increase is superior to that of stature for one segment of the body, it is inferior to it for the segment situated immediately below or above. There is there a novel aspect of the law of alternation which can be expressed in a more general fashion: *The law of alternation governs the proportional increases of the segments of the body, as it governs their absolute increases.*

The variations of the proportions of length and of breadth of the body are profoundly modified by puberty which subjects them to the laws of orientation and augmentation.

Such segment which progresses relatively more than the stature until puberty falls behind beyond the puberal age: this is the case of the pelvic members. Such other segment which falls behind the stature before puberty gains on it when puberty is crossed. So then: *Puberty has a decisive influence on the direction of the variations of the proportions of length and of breadth.*

The proportions of breadth, in general, present their own variations which are in correlation with those of the proportions of length of the trunk.

The reduction of the proportions to height of the visceral cavity reaches its extreme limit at puberty.

. . . . . .

Principle of irregular growth.—Among the puberal laws, there is one of them which derives directly from the embryogenic power of which puberty gives proof; I mean the principle of irregular growth, in its physiological rôle and in its eventual pathological rôle.

The effects of irregular increase are subject to the law of alternation and remain physiological.

As soon as a cause makes irregular increase escape from the law of alternation, its effects are in danger of becoming pathological.

Besides traumatism, infection, intoxication, neoplastic production, etc., poor prefoetal, foetal, and postfoetal alimentation retain a preponderant influence.

Before leaving this important question of laws of growth which must be present in your mind in the course of your

observation of the child and of your direction of education, I believe I ought to give you a résumé of them with concise formulations.

RÉSUMÉ

I. LAWS RELATIVE TO THE ALTERNATIONS OF GROWTH

1. Long bones grow in thickness and lengthen alternately and not simultaneously. The periods of repose in elongation are utilized by the growth in thickness (1 and 3[2]), Plate X, D.

2. The periods of activity and repose which succeed each other half-yearly in the increase in length of a long bone are opposite for two long bones consecutive in the same limb (1 and 3), Plate X, C and D.

3. The half-year represents the average duration of alternation of a great number of increases; thus a long bone grows in thickness during six months more than it lengthens; then it lengthens during the following six months more than it grows in thickness.

The great alternations evolve around puberty. (3.)

4. Height owes the greatest part of its development, before puberty to the lower limbs, after puberty to the bust (1 and 3), Plate X, A.

5. The principal peripuberal increases in height are produced during the two semesters which precede the dawn of puberty. The principal peripuberal increases of weight take place during the very semester of the dawn of puberty and during the two semesters which follow (1 and 3), Plate X, B.

6. Growth is especially of the bones before puberty and above all of the muscles after puberty (1 and 3), Plate X, C.

[2] Figures refer to publications, p. 120.

II. LAWS RELATIVE TO PUBERTY

The germen is the continuous axis of life around which gravitate, partially alternate, organization and disorganization.

1. Puberty is the key of growth.

2. The début of the shoot of the pubic hairs P^1 precedes by three semesters on an average the dawn of puberty P^3 A^1.

3. In the masculine sex, the début of the shoot of the hairs in the arm-pits corresponds to the dawn of puberty (1). In the feminine sex, it appeared with a slight retardation upon the first menstruation according to Dr. Martha Francillon.

4. P^5 A^5 which mark the end of the puberal phase, occur four semesters approximately after P^3 A^1 (1 and 2).

5. Twelve to seventeen years separate puberty from birth. This is the prepuberal period of growth. Two years suffice for its establishing and constitute the puberal period. Beyond that, three years are necessary to attain to nubility, three years which represent the duration of the post-puberal period of growth, or the inter-nubilo-puberal period (11).

6. Puberty is precocious or delayed according to the value of placental alimentation (9 and 11).

7. Puberty is the *period of maturing of the organs of reproduction;* it answers to the maturity of the encephalon, but marks merely the début of the last stage of the soma towards maturity (9), Plate IX.

8. Puberty determines normally some inequalities of growth which have for object the definite appropriation of the soma to the function of reproduction, but they often carry with them some temporary troubles, not pathological. Such are the change of voice, the "vergetures" of growth,

such are a great number of other troubles which determine in the scholar some various ills by psychical repercussion (9 and 10).

9. The duration of the effects of irregular puberal growth depends upon that of alternation of growth to which it is connected. If it is prolonged, it is that the action of a contingent cause preserves it from the law of alternation, and in this case, the troubles assume a pathological character (9 and 10).

10. Puberty has an inverse action on the pigment according as it concerns the pigment of the skin and hair which it darkens or of the pigment of the iris which it lightens (1).

III. LAWS RELATIVE TO THE PROPORTIONS DURING GROWTH

Plates I, V, VI, VII, VIII and XVI.

1. From the child just born until manhood is reached each segment has its own manner of behaving towards height (4).

2. If the proportional growth is superior to that of stature for one segment of the body, it is inferior to it for the segment situated immediately below or above (4 and 8).

3. Such segment which progresses relatively more than the stature until puberty, falls behind beyond the age of puberty and vice versa (4 and 8).

4. The proportions of breadth in general present some peculiar variations which are in correlation with those of the proportions of length of trunk (7 and 8).

5. There are three phases in the evolution of the variations presented by the proportions of length and breadth in the course of post-foetal ontogeny; the first phase ex-

tends from birth to six years, the second from six to fifteen years, and the third from fifteen years to adult age (8).

6. Some proportions determined for each category of the organic constitution answer to the puberal period and very often even to the dawn of puberty (11).

7. The proportions consequently allow of an acquaintance, in a close manner, with the space of time which, at a given moment, separates a child from puberty, that is, his puberal age, his age of evolution (11).

8. At six years, on an average, about nine years before puberty, the proportions are such during a semester or two that the silhouette of the child indicates that of the future man (4 and 8), Plate I and especially II and XVI.

IV. LAWS RELATIVE TO ASYMMETRIES

1. Between the binary organs a correlative asymmetry of hyperfunction governs; in the right-handed, the right upper limb is longer and thicker, the right shoulder lower, etc., characteristics which pass to the left side in the left-handed (5).

2. The evolution of normal asymmetries of binary organs and of the trunk progresses throughout age in a sense inverse to growth, but in the same direction as function (5).

3. In right-handed, the superiority of length and of thickness which is on the right side for the upper limbs, is often situated on the left side for the lower limbs, which fact determines a crossed functional superactivity. In the left-handed the crossing is reversed (5).

4. The auricles of the ears show a notable and constant asymmetry without apparent functional correlation which growth tends to efface (5 and 6).

PUBLICATIONS IN WHICH THE FACTS LEADING TO THE LAWS ARE ANALYSED

1. *Recherches anthropométriques sur la croissance des diverses parties du corps.*
2. *De la puberté à la nubilité.* Société d'Anthropologie, 7 juillet, 1909.
3. *Alternances des accroissements (semestriels) au cours du développement du corps humain (dans le sexe masculin).* Société de Biologie, séance du 25 juin 1910.
4. *Les proportions du corps pendant la croissance.* Société d'Anthropologie de Paris, 1910.
5. *Asymétries normales des organes binaires chez l'homme.* Académie des Sciences 1900 et 1910.
6. *A propos d'asymétrie auriculaire.* Société d'Anthropologie de Paris, 1910.
7. *Variations des proportions de longueur et de largeur du corps dans le sexe masculin au cours de l'ontogénie post-foetale.* Académie des Sciences, 1911.
8. *Variations des proportions.—Leurs lois évolutives.* Académie de Médecine, 1911.
9. *Essai d'explication du rôle de la puberté chez l'homme.* Société d'Anthropologie de Paris, 1911.
10. *L'accroissement inégal à l'époque de la puberté.* Académie des Sciences, 1912.
11. *De quelques rapports de l'évolution de croissance avec la puberté.* XIV^{me} Congrès d'Anthropologie (Genève, 1912).

PART II

APPLICATIONS TO EDUCATION AND PEDAGOGY

" . . . *L'anatomie et la physiologie humaine, ont besoin de l'histoire de développement de l'homme après comme avant sa naissance. La psychologie n'y est pas moins intéressée. La médecine, l'hygiène et aussi la morale, l'éducation physique et intellectuelle, tout cela doit en bénéficier par là même.* . . ."

L. Manouvrier,

(*Préface des "Recherches sur la Croissance des diverses parties du Corps" de Paul Godin, p. 11*).

CHAPTER I

UNEQUAL GROWTH IN THE SCHOLAR. ORGANIC TROUBLES WHICH PROVOKE IT AND OF WHICH THE TEACHER AND EDUCATOR HAVE TO TAKE ACCOUNT

Of what unequal growth consists.—Interest of education in the troubles which it determines.—Examples of puberal troubles due to unequal growth.—Pedagogical consequences of these troubles.

Of what unequal growth consists.—We have just determined what we ought to understand by unequal growth: in an identical organ, the play of augmented and reduced growth creates some inequalities of the kind which have been observed in the first hours of life.

In the embryo, these irregularities of growth had for object the construction of the organs. In the child who is becoming pubescent, the organs are formed; so the end of unequal growth is no longer to achieve their perfection, to render their functions more easy, and more in harmony with the new needs or at least the orientation quite different from the needs of the being soon capable of procreating.

It is normal, in the child, that the progression of the effects of unequal growth should last about one semester, a limited duration which leaves only in relatively rare cases, to the trouble outlined by non-parallel growth, the time to assume the importance of a pathological state. That arises from the effects of unequal growth not having escaped the law of alternation. However, there are some cases where

the consequences of a poor placental alimentation, that which causes delayed puberty, suffice to preserve unequal growth temporarily from the law of alternation and to prolong by one semester the progression of its effects.

The functional equilibrium is from then on menaced. The physiological condition is still maintained if the anatomical constitution is not affected to the point of obstructing it too much and if the functional appropriation can be realized.

However, the limits of the physiological state are eventually found exceeded by the persistence of the inequality of growth; from the moment when the functional appropriation can no longer take place without injury to the organism, the pathological state is very near to being created. This state proceeds, moreover, from the pathological condition from this fact, that it implies a lessening of the human activity, a reduction of resistance, from this fact, that, if it is established in a definitive way, it harms or arrests balanced growth, with the fine regulation of its proportions and, in the last analysis, determines a diminution of the chances of happiness of the individual and of his social worth.

However, the limits of physiology are habitually exceeded only as often as an external cause intervenes, such as a traumatism, an infection, a neoplasm, which cause several successive phases of alternation to be crossed without remission.

Interest of education in the troubles due to unequal puberal growth.—It is conceived that the cases are numerous in which, while remaining at the limit at which physiological deviation is produced, without that there should be further morbid disorganization, some real troubles are nevertheless constituted.

These are those ill-defined states which do not draw the attention of the family by any frankly unhealthy appear-

ance, of which no disquieting symptom provokes the calling of the physician, these are precisely those mixed states which interest the educator, and must be ferreted out by him; for between them and the psychic character of the scholar reigns a close union the forgetting of which ruins the psychology of the pubescent and is full of sad educational and pedagogical consequences.

Such is, in short, the pathogenetic mechanism of puberty which rests, as is seen, upon the physiological tripod; embryo-foetal nutrition, unequal growth, and the law of alternation.

The factors which can eventually intervene are before all traumata, infections, and intoxication, these latter ordinarily originating in the digestion and proceeding from poor alimentation of early age, that is, from everything which is not *the nursing by the mother, sole alimentation appropriate to the needs of the child and to the maintenance of its organs in a state of normal functioning.*

Puberal troubles from the side of the larynx and of the tegument.—In the larynx, in virtue of connective and muscular augmentations determined by puberty the thyro-arytenoidal ligaments and muscles suddenly elongate, and more than is suited to the space between their extreme points of insertion.

Up to that time the cartilages have grown. At this moment they cease to grow; or rather they reduce considerably the rate of their growth, so that the arytenoido-thyroidal space is not proportional to the length of the connective-muscular elements of the vocal chords. At the end of a phase of alternation which can be extended to several semesters, the cartilages recover their activity of growth, the arytenoido-thyroidal digression is harmonized with the length of the chords.

The voice, at first shrill, then tremulous, takes on firmness at the same time that it realizes its definite tonal quality and timbre. Emasculation maintains the shrill voice because it suppresses the germen, and as a result, puberty with all its consequences, with its augmentations bearing on the growth of connective and muscular tissue, with its diminutions affecting among others the cartilaginous tissue. So that puberty being suppressed, everything which grows by the cartilage, continues to increase. The chords, on the contrary, remain stationary, and, throughout age, continue the chords of a child. They are too short for the greatly increased space which is between their extreme insertions.

On the part of the skin, growth, it is known, is reduced or arrested when puberty approaches. The skin is, in fact, of ectodermic origin, and puberty reduces or arrests in the same way the growth of divers others derivatives of the ectoderm.

If an infection occur and determine an exorbitant elongation of the long bones of the lower limbs, as is seen in the last stage of serious illness, the skin is not able to follow this increase. The infection acts like emasculation, in exaggerating the activity of the cartilage, in inhibiting the growth of connective and muscular tissues, in causing the phases of physiological alternation to transgress this irregular growth.

The skin is stretched to such a point that its elastic elements (Troisier and Ménétrier) end in breaking themselves following one or several transversal lines above the knee-pan, and leave behind as a result one or several white bars called "vergetures de croissance," analogous to those which striate the abdominal teguments of women who have been pregnant several times.

Puberal troubles on the part of the limbs.—We are

called to observe during the period of installation of puberty some muscular hernias by aponeurotic rupture, some myopathias by rupture of the muscular fibres. The stretching which determines these ruptures is the fact of unequal growth. A sudden lengthening of the long bones may correspond in the child, more or less maltreated during his intra-uterine life, to a repose of the growth of the muscles and connective tissue.

That condition is often produced several semesters before the appearance of puberty. From thence come, in the segments of the limbs, in the legs, in the thighs, a stretching of the muscles, of the nerve fibers, of the vessels, of the aponeuroses, of the periosteum with some various accidents or merely painful sensations. They can be very vivid, the pains felt by the child; they are ordinarily deep-seated, indistinct, without very precise localization.

The instability of the child is the natural effect of it. *It does not delay in reverberating on the psychical state of which the teacher cannot interpret the trouble if he is not acquainted with these special conditions of development.*

From the right or wrong interpretation of this instability can result the most grave consequences for the present and the future of the child. I have seen some scholars become bad subjects as a result of punishments incurred during this period for some reasons born of their sad tortures; they were suffering and their sufferings were not understood. They were not able, in spite of the efforts of their young will to govern the need of changing the position of the painful limbs. The agitation, evidently deplorable in class, was attributed to some causes of another order, as well for the good pupils "about to be spoiled," it was said, as for the bad.

From everything difficult and confused which there was

for the child in his discomfort and his bewilderment of false human judgment, this impression stood out: "The punishment inflicted is unjust."

"If I move all the time," exclaimed one of them, a good boy, choking with indignation, "Monsieur, I swear that it is not my fault."

"It is an intolerable distraction," replied the master, made impatient by the unlucky influence of this disturber on the thirty-five other pupils in the class, and the punishment was maintained.

Doubtless he was turbulent, this scholar, but whose duty was it to recognize the cause of his agitation? It cannot be a question of carrying into the domain of school the irresponsibility which inhibits social selection while stifling the action of discipline and that of justice. It is a matter solely of distinguishing the physical condition of the child, and of recognizing with precision the cases liable to correction and those which merit treatment. The educator and the physician must by their collaboration give satisfaction to this inalienable "right of the child," by enlightening themselves mutually on the conditions of growth.

That gives you an idea of the importance of the educative and pedagogical effects of erroneous information relative to the conditions which an organism in the travail of growth presents.

In the bust, in the limbs, if skeletal elongation has been outstripped by that of muscular and connective tissue, a relaxation is produced, a kind of wavering. A part of the work of the contraction of the muscles is rendered inefficacious, and the effort necessary to the act passes from single to twofold for an equal output, whence the rapid fatigue and its results.

Let us note in passing that acquaintance with these di-

verse conditions is important to the psychologist as much as to the educator, and for reasons of the same order, namely, the interpretation of individuality. Judgment runs all the risks of being false if the existence of one of these conditions has not been ferreted out in the scholar before subjecting him to psychological experimentation.

Troubles of puberty on the part of the vessels, the viscera, the spinal column, the joints.—The venous circulation is liable to arrest as a result of the relaxation of the walls of the return vessels which the muscles and aponeuroses of the limbs no longer support sufficiently.

If the scholar sits on the flat of his thigh, as the high seats and the equilibrium of his body oblige him to do, it is at this moment that there is prepared the inception of varices which spread out a little later without that the immediate causes, at the time when they are detected, allow of an explanation of them.

The serous folds, the suspensors of the viscera, lose their normal tension and what has just been said of varices holds true of visceral ptosis. It is often at puberty that visceral ptoses are initiated, or at least that they are set up anatomically.

The spinal column is seen relaxed between two connective-muscular bundles, lending itself to accidental influences, school and otherwise, and bending itself while being twisted more or less as a result of the inequality of the lengthening of the vertebral ligaments or in the direction of functional right, or left-handed demand, thus setting up a necessary scoliosis.[1]

The articulations, on their side, take as a result of the relaxation of the articulatory ligaments, a laxity singularly

[1] Academy of Science, notes on the "Asymétries normales des organes binaires chez l'homme," February 19, 1900, and October 3, 1910.

favorable to intra-articulatory traumatisms with friction, bruising, contusion of the cartilaginous or synovial surfaces, and consequently to arthralgia, to arthritis, independently of all special predispositions, to dislocations (subluxations), to serious temporary deformations of the multiarticular segments such as the wrist and ankle.

Puberal troubles through inordinate growth of segments of the spinal column.—Unequal growth can injure two tissues of which the one serves for the gain of the other. Let us take for example the effects of unequal growth on the vertebral column and on the medullary nerve axis which it incloses.[2]

Normally, puberal augmentation elongates the spinal column. This fact has already been mentioned apropos *puberal alternation* in these terms: "height owes the greatest part of its development before puberty to the lower limbs, after puberty to the bust," to the spinal column, consequently, augmented by the height of the cranium.

At the same time, the nervous tissues, centers and nerves which spring from it, nerve threads of the great sympathetic system itself, experience a reduction in their growth. So that the spinal cord, which needs, however, only a quite slight growth, by reason of its special relations with the vertebral column, does not succeed in realizing it. If the lengthening of the spinal column should be ever so little with a certain suddenness and attain important proportions, divers accidents can result from it. These accidents take a definite character when the increase bears exclusively on a single segment of the spinal column. The seat of predilec-

[2] Longueur relative de la moelle et du rachis," chapter xvi of *l'Etude sur les rapports anthropométriques en général, et sur les principales proportions du corps,* of Professor L. Manouvrier, in Mémoires de la Société d'Anthropologie de Paris, v. II, 3e série, 3e fascicule.

tion of this "local gigantism," of this exaggeration of length of segment, is the cervical spine of the child.

The tension which the cervical segment of the spinal cord undergoes, having become too short by the fact, is transmitted to the brain, and there result from it some nervous manifestations which can terminate in Sydenham's chorea, when the tension is moderate, when it reacts on the *thalamus opticus* and not beyond, and when the disparity of increase between the spinal cord and spinal column is of short duration (phase of alternation). But these manifestations can go much farther, until to epilepsy, as observation and experimentation have demonstrated to me, if the effects of the tension are felt by the brain cells of the grey matter and if several phases of alternation are transgressed.

Phenomena of this order appear in some children who show diverse accidents (such as traumatisms, infections, tapeworm—two personal observations—etc.), of a nature to favor for a longer or shorter time before the puberal period, unequal growth to which they are already disposed by the poor quality of placental alimentation.

Choreic movements of puberal origin.—"Some disparities (*disjonctions*) of lesser importance are produced under the influence of causes less accentuated." That is quite frequent, and I especially call the attention of the educator to "the choreic movements" which are met in 6 to 9 scholars of every 100 normal ones, and of which the greater part of the voluntary muscles are the seat, but especially the long muscles of the lower limbs and also those of the upper limbs. By reason of the circumstances disclosed by half-yearly observation of the same children, I believe choreic movements ought to be connected with unequal growth. In each of the children affected with choreiform movements periodic

observation has disclosed unequal growth with transgression of alternations; just as in scholars affected by tic-douloureux or facial neuralgia. But in these two groups, the manifestations of unequal growth were different. In the latter case they were of the cranium; in the other of the spine. In both, unequal growth multiplied its effects throughout the organism and often continued them several consecutive semesters.

Do not confuse the tics which are local, contract singly such or such group of muscles, and determine some twitches continuously the same with choreic movements which are not localized and appear simultaneously at several points of the organism and assume neither the aspect nor the periodicity of tic. Nothing is easier, however, for the educator than this diagnosis; for there is unfortunately no class where there are not found one or several children affected with the tics, or with something like it, with which it is possible to make a comparison.

Choreic movements bring on some disturbance, a little like the pains of growth, but disturbance localized, in some fashion, and a disturbance which is not here provoked by pain; it is the direct effect of the contractions, of muscular twitchings, however reduced they may be.

If the child has not been undressed, if the physician or the educator has not been able to see with his eyes the fibrillary contractions of the muscles, he does not and cannot know from what cause the physical instability arises and consequently the unsteadiness of the child who now finds himself exposed to the reproaches and perhaps to punishments, evidently unjust, since he is no more master of these little useless and often ill-timed movements than he would be of the large movements of Sydenham's chorea.

I repeat, these "choreic movements" are much more fre-

quent in scholars than is imagined. Now, twelve years of teaching and thirty years of practice in medicine would have made me acquainted with nothing at all regarding them and their consequences if the examination of the stripped child had not presented to my eyes the vibratory trembling of the muscular bundles.

They are observed sometimes as early as the age of eleven or twelve years, but it is above all, in the neighborhood of the appearance of puberty that the "choreic movements" manifest themselves. I have never seen them degenerate into chora; and on the other hand, they last longer than the plainly choreic manifestations. They are involuntary, painless, unconscious, can be neither arrested nor even limited by the subject.

From the pedagogical point of view, I must appeal to the benevolence of the master and ask him to cut short, as often as his instruction and good order in his class will permit him, the school hours of immobility for every child suffering from choreic movements. It is understood that as soon as it appears, his case will be submitted to the physician who, without subjecting the child to a discipline of which he has more need than ever, will have to orientate him in the desired direction by special hygiene.

These diverse circumstances of the puberal life of the child would create, if one did not take pains to know them perfectly, a host of quasi irresponsibilities which would render the mission of the educator terribly delicate. There are still other circumstances which it is also necessary to know very well for they represent just as many exact duties for the direction of education.

Contagious tics of puberal origin.—Such is the case of the tics. One day in 1911 I was passing through a little town of the French Jura, when I saw coming trooping along a

school of girls. The pupils were numerous, many middle-sized and a few large. While walking, they were chattering and accompanied their gossip with a mimicking, intense, exaggerated, and singularly jerky. They made grimaces or shook their heads affirmatively or negatively. And, moreover, the conversation, carried on in a high key, had no relation at all with the energetic signs of denial or affirmation. And the speculation of the girls continued to unfold, showing new heads shaken by these useless movements, always the same.

There was no doubt possible; this school was the victim of an epidemic of tic. I experienced some regret at not being able to set out in quest of the source of the epidemic, when, in her turn, the mistress passed, holding by the arm, a pupil of thirteen to fourteen years old. Both, without looking at each other, were making with their heads, movements more extended, more jerky than those of all of the rest of the young flock. There was the origin of the contagion. It was the mistress herself. I had the confirmation of it. And in fact, her favorite pupil surpassed all her schoolmates and showed herself suffering in the same degree as the mistress whose jerkings she copied faithfully.

Without doubt, the public authorities are right, a hundred times, in taking account before all, of the intellectual and moral worth of the masters whom they place over youth. But, by this example, which calls up many others, one can see how grave is the responsibility which rests on them when they do not protect the children which the families confide to them, against an avoidable contagion, according to the very expressive word of Brouardel.

Nothing is so easy for a master who observes, as to grasp the door of entrance into his class of the tics and to specify this one or that one who has brought in the favorite move-

ments. The pupil himself who has brought them in, it can often be assured, has taken them from a comrade in the home where he lives, from the court-yard or garden where he habitually plays. I knew a little girl who seemed to be the only person in her community to have the tics. A little later, I noticed in the street another child presenting the same tics, and I learned that these little girls passed each other twice a day in going to their respective courts.

In a gathering in which girls retain their large bonnets, nothing is so comical as the agitation in every direction of this motley-colored mushroom bed where are distinguished some other hats shaken by the tics of the little human beings which they cover; and the thought of the infirmity arrests the impulse to laugh which the drollery of the sight had just provoked.

Tic can be transient but it sometimes continues in the young man or the young girl; it can even persist throughout life. I know a brilliant general officer who has retained in his eyelids the tic of his infancy and young grandmothers who still shake their heads as at fifteen years.

My observations in some varied occupations have led me to consider the general prevalence of tic in the school-child, as an effect of contagion to which the child in travail of puberty is exposed, as a result of unequal growth which increases the gain of the cranium at the moment when the rate of growth of the nerves (reduced puberal growth) is reduced, and thus creates some mechanical causes of cerebral excitation. Certain children who had not contracted the tic prevailing, professed regret at not being able "to do as the others." Tic at school becomes a fashion.

Not all tics are contagious but I am speaking only of contagious ones because their relations to puberty are exceedingly close, since they are connected with unequal

growth. Masters have every facility to make out the contagion and its origin, a thing which is not always within reach of the physician not called to share the life of the child.

As to original cases, cases which are the point of departure of the contagion, they arise from the nervous pathology of the adult who is outside our field.

Onanism of puberal origin.—When onanism becomes a menace to health, it ordinarily arises from pathological causes; but there are some cases where it derives from manifest effects of unequal para-puberal growth. It is under this head only that it is under consideration.

As for the headache of growth and for the tic, the disturbing cases of onanism that I have known of in the schools and in families, touched some subjects somewhat removed from their puberty. Periodical examination caused me to verify in most cases the absence of a local provocatory cause but a sudden augmentation of cranial dimensions. Now, this augmentation arose in some children of moderate intelligence, by no means overdriven, at the moment when puberal preparation reduces or arrests the growth of nervous tissue. The abruptness of the augmentation of volume of the cranium denoted the intervention of unequal puberal growth. The other causes eliminated, I believed I was able to connect onanism to this mechanical cause of psychical trouble. Appropriate regulations of physical exercises, a varied intellectual culture, select and notably more intensive; the suppression of all alcoholic drink, the treatment which I instituted for unequal growth,—by these means I obtained in a few months a change of aspect of the general condition of these subjects which implied the effective correction of the "psychical deviation." But, outside of these

cases coincident with puberty, inveterate onanism is always a malady which has an unhealthy setting.

Let us then turn the patient over to the physician, and let us, as educators, charge ourselves with the search of the causes springing from the moral atmosphere, from the environment, from comrades, from friend, from readings. Then, according to the results of this double inquiry, let the direction of education be orientated with firmness.

In all cases, the educator needs great skill. He will be severe in the choice of relations and will ruthlessly turn away the dangerous example; he will exercise a loyal surveillance, and will attempt to inspire confidence in the subject rendered distrustful by his very vice.

With some, the educator will be able to reason, while refraining from all exaggeration relative to the evil or to its consequences. He will have constant regard of truth, and will never forget that the physiological truth is the wholesome education, the wholesome example, the moral cleanness of the air which the child breathes. Such is the physiological truth because such is the safeguard of the chronology of functions.

These are the reasons why, from whatever side one regards it, the above-mentioned deviation is a resultant and arises above all from the first education which penetrates the child under cover of breeding. There is very little onanism among children nourished and reared by their mother.

CHAPTER II

GROWTHS BY GREAT ALTERNATIONS. WHAT THE EDUCATOR AND TEACHER CAN INFER FROM IT

Alternate rhythm of growth for the spinal column and for the cranium.—Alternations in the development of the germen.—Relative independence of the evolution of growth to great alternations.—Relations between them and with puberty.—Pedagogical and educational deductions.

ALTERNATE rhythm of growth for the spinal column and for the cranium.—Alternation is a synonym for us of the succession of repose to effort, and of effort to repose in the growth of an organ. I refer to relative repose, of course. We were acquainted with the short alternations or at least with a certain number of them; we now mean those which extend over several years. The growth of the spinal column is of this number. Its alternations are of long duration. Very active in the course of the intra-uterine life, it diminishes from birth to puberty, to the point of attaining at that moment, its slightest proportional length.

As early as the appearance of puberty, the spinal column again begins to elongate so as to contribute from now on more than the lower limbs to the elongation of the stature and that continues until the adult state is completed. Plate III.

The cranium offers another example of great alterna-

tion of growth. It expands in every direction in the foetus and presents already at birth 30/100 of the volume which it will have once an adult. Plate IX. Its growth undergoes no arrest at all in the well built child, and continues actively until about the age of five years when 80/100 of its final volume is attained. Beyond the age of five years, the growth of the cranium acquires in ten years the 20/100 of the increase which will permit it to be adult at puberty.

The rests of alternation are not marked by any arrests, either for the cranium or for the spinal column, but only by some diminishing of the activity of growth. The cranium attains the adult state at puberty approximately, and, although its activity of growth has been continued, it is shown to be very irregular, taking nine months to realize the first third of its final volume, then five years to acquire the second third, approximately, finally ten years to make up the remaining third.

Alternation in the development of the germen.—But the alternation of the evolution of the germen is much the more accentuated. Its development, that of the seminal issue, is made during the intra-uterine life except the last stage, which consists in the ultimate modification of the spermatid into spermatozoon. This final transformation is equal to the last part of the growth of the germen. The transformation will be effected at the time of puberty, a time of which it decides, since it is the essential phenomena of the transformation. Plate IX. During the whole period which extends from birth to puberty, the repose of the germen is complete.

Relative independence of the evolutions of growth to the great alternations.—The three organic factors are considered here, the germen according to anatomical and func-

tional notions, G, the brain according to the volume of the cranium, C, the soma according to the volume of the trunk, V (see p. 222).

Their comparative evolution presents to be considered (a) the modality of the development and (b) the relative rate of this development. Plate IX.

(a) *Modality of development.*—The *germen* is developed in two leaps with an interval between, the one uterine, the other puberal. The *brain* is developed in two successive leaps, the one before birth, the other soon after. The *soma* is developed without making any leap, from the germ to the adult.

(b) *Relative rate of development.*—At birth, the germen attains already to a near point, about 95/100 of its total development. The brain attains 30/100 of its total development. The soma (trunk) realizes only 6/100 of its adult state. Plate IX.

At five years the germen is stationary. The brain attains to 80/100 of its adult state. The soma still represents only 30/100 of the adult soma.

At 15½ years, the germen is adult.

At 15½ years, the brain is adult.

At 15½ years, the soma is not yet adult.

Such is, in the course of growth, the manner of behavior of the three great organic components of life. It can be translated thus from the point of view of its educative consequences. "The transformer-distributor (soma) of the elements of nutrition is developed with regularity in the healthy child, *from the germ to adult age*, the age which is determined by the very achievement of its growth.

The soma is outstripped by the germen and by the brain which are adults from the time of puberty. Now, while the perfected soma is an important condition of the best

germinal function, it is only a secondary condition of the best cerebral function.

On the morrow of puberty psychical activity will then not at all escape an educative direction which will have prepared this post-puberal period, but this direction will have to take the greatest account of the germinal maturity which is not the functional maturity, since a condition of great importance still is missing, but which is found at every instant solicited by the trend itself of psychical culture.

Before puberty, in the course of agenital life, psychical activity is *entirely free.* The cerebral function is in readiness, since somatic perfection is not a functional condition for the brain, since the immature germen lies dormant, since finally, the brain is in possession of all its cellules, which have no more to do than to be hypertrophied, that is, developed to an unusual degree.

It depends upon education whether cerebral hypertrophy becomes a riches or a poverty, a benefit or a menace for society as for the individual. To leave this work of hypertrophy to be effected unrestrainedly, is to abandon the cerebral "furniture" (*ameublement*) to the street, to the educational carelessness of society, which accumulates hideous examples with a monstrous blindness of will.

Education is entirely responsible for the worth of the cerebral acquisitions of the whole period of infancy. During this period of "agenital life" the influence of the germen makes itself felt somatically or cerebrally, only in the anormal, and, at least for the pathological state, it is of education that it is necessary to demand account for any deviation.

CHAPTER III

VARIOUS PEDAGOGICAL APPLICATIONS

Pubescents and non-pubescents.—Their somatic and psychical differences. Pedagogical deductions.—"Educative movement" of each organ.—Deference to the law of alternation.—Growth and intelligence.—Position of scholar in schoolroom, necessity of varying it.

PUBESCENTS and non-pubescents.—The life of the child, until his transformation into an adult, forms two parts with puberty as the center. The child is prepuberal or he is post-puberal, if one may thus express himself, and more simply, the child, the scholar, is pubescent or he is not, the puberal period itself being only a point around which gravitate the disclosing transformations, which tend towards the desirable perfections for the integral conservation of the race.

Prepuberal, that is the child. Post-puberal, that is the youth. The child continues to grow into the youth, but we know what profound differences mark this second part of development.

This fact is capital for the educator and explains for him the different fate of the same procedures in regard to the same child at these two periods, or in regard to scholars of whom, although of near ages, some are pubescent and others are non-pubescent.

Somatic and psychical difference between pubescents and non-pubescents.—Their bodies are at different degrees of de-

velopment which their proportions express clearly. Their brains may be very much alike, if their education and their culture have been the same; but the brain of the non-pubescent is free; the brain of the pubescent is under the influences of the conjunctive proliferation of puberty and of the germen.

Outside of these cerebral conditions and outside of the mentality which ensues, the phenomena of augmentation, of reduction or of arrest, of total growth or of involution, affirm this distinction between the prepubescent and the post-pubescent. The special pathological and para-pathological troubles of puberty complete the establishing of the difference.

Let us understand thoroughly: "special pathology" does not signify here all the affections to which the puberal period is exposed. By special puberal pathology, it is necessary to understand the troubles provoked by the very essence of the phenomenon of puberty; those which are produced only at the moment of puberty, around it and because of it. The troubles which constitute the special pathology of puberty, are, in proper terms, the deviations from the physiological condition which result from irregular growth and from poor placental nutrition, just as, in a large measure, of the alimentation of the year which follows birth.

The non-pubescent is a lad who is separated by a greater or less number of years from the adult state; the pubescent is a youth who is at a precise distance from his nubility, who will be an adult in five years, if he is beginning his puberty, in four years if it has appeared the preceding year, in three if the dawn of puberty dates two years back in him. This youth is only seventeen years old, and he is already an adult because he has been pubescent from the age of twelve years, as in the case cited above of the twins of which one, not yet

pubescent, will be nubile at the earliest at twenty-two years.

Pedagogical deductions.—You will indeed foresee that the process of education or instruction suitable for one is in no way appropriate to the other. According to that, you will comprehend further, that, excepting the family fireside, boys so different as pubescent and non-pubescent are, cannot dwell together, share the same life, exchange ideas without harm for the non-pubescents who will not delay imitating the pubescents in all their doings and acts; this will be injurious to both, but it offers for the non-pubescents a veritable danger. From that source spring disorders too often irreparable.

Recall what puberal alternation of organic growth has taught us. The brain which possesses the cellules which it had already since birth, cellules which it has not at all renewed, of which it has not increased the number but only the dimensions, the brain is going to become adult at the time when puberty dawns; it will lock up in its gangue henceforth inextensible, the instruction gathered earlier; it will graft the new notions on the earlier acquisitions; *all cerebral elaboration will bear, more or less apparent, more or less dissimulated, the imprint of the instruction and of the education received up to that time.*

Before puberty you have had the field open to all culture, but also to all imitation, to rapid and precise assimilation. Look to the examples, and, if unfortunately the family has not taken this care before you, educators, apply yourselves at the earliest possible time to the task of correcting the moral and psychological deformities and do your best, but do not hope to efface anything whatever. Hasten to utilize the prepuberal liberty of the child's mind, for tomorrow, dominated by the triumphant germen, he will become clumsy

and subject to fatigue, almost closed in the domains where he was the most open.

Happy if your sowing has been done with tact, with discernment, if the examples with which the senses have furnished the brain are all stamped in the coin of a pure morality. For, no one can count on taking away from the cerebral museum the image of an evil act, the immoral scene which an imprudence has suspended there in past time. It remains there and its recall can carry along with it the worst consequences to remote repercussions. Puberty will soon be initiated, and the youth will make you pay dear for your errors towards the child, for your forgetfulness, your negligence.

There is an educative moment for each organ.—Each organ, according to its development and its possibilities has its "educative moment," a moment more or less extended in time, but in which the organ will really offer an excellent state of educative receptivity, if one has taken care to prepare it. Thus the moment for the brain is prepuberal by the motives which we know. It begins at the early hour when the senses commence to inform the brain.

It belongs to the educator to conform his orientation, to adapt his method to what he can discover from the individuality of the little child. Individuality exists. It is a question of knowing how to discover it. To the educator comes the appreciation of the dosage of notions, but above all of their choice. For the lessons here are all made up of example, of manner of living, of evenness of humor, of firm and gentle will, of order, of regularity in duties; they are made of images, of those very ones which are hung on the walls of the chamber, forming the habitual horizon of the child.

Prepared since the first hours of understanding, the direction will be excellently done and more and more easy. Doubtless, in course of the years which constitute the second period of evolution, from six to about fifteen years, by the side of the useful provisions there are also made the useless and the dangerous, and that, in spite of the educator who, however, will be able to overtake, at an advantageous time, the fleeing personality of his pupil, if he has been informed accurately on it by some periodical examinations, by a methodical and wise observation.

It is clear that an educator warned in this way, will not follow, in order to reach the citadel of the child whom he directs, any paths whatsoever, but those which the notions acquired on the individuality of the child mark out for him. He will have to conduct himself according to the knowledge of his temperament, otherwise expressed, of the share of energy of which he disposes, and of the fashion in which he dispenses it, of the rapidity or the slowness with which he recuperates and of the time which he needs for this recuperation. He will guide himself by the relation between the duration of effort and the duration of recuperative repose, $\frac{r}{e}$ (see the individual formula).

Deference to the law of alternation.—You cannot give yourself an idea of the influence on the present and future organic functioning, of the deference or of the transgression of a phase of repose after a phase of effort. The organic alternations of activity and of repose are applied to all the manifestations of the life of the child as to his growth. It is imposed on the speedy as on the slow; the former succeeds, nevertheless, to lengthen temporarily the phase of activity at the expense of the phase of repose.

Transgression of the natural alternation of the individual

leads to an organic unbalancing for a short time, or for a longer time (jading) according to the individual resources; in those who resist, thanks to the riches of their resources, it happens that later an organ causes them to feel that there is suffering for it (heart, brain, digestive apparatus), or that the advantageous effects sought for by impulse do not subsist.

Alternation and intellectual growth.—In the intellectual order, the effects of transgression of alternation are not better. The teacher has the greatest interest in causing this law of nature to be respected by all; the application of it to scholars demands, nevertheless, skill and a perfect knowledge of their individuality, the phases of work and of repose varying their relative duration with each one.

But this application of the law of somatic alternation to cerebral activity is, for the instant, outside of our domain. It represents one of the aspects of the relation of growth with intelligence, it is true; and this chapter which comprises the relations of the growth of the brain with its psychical manifestations on the one hand and with the growth of the soma on the other, which makes a study of the various influences on cerebral development of the factors capable of accelerating it, of retarding it, of arresting it, and their repercussion on the intelligence, could be made the object of a study which would henceforth have a solidly established somatic basis.

Moreover, you will find matter for reflection on this subject in the elements met with in the course of the chapters which precede. I call your attention specially to the augmentations by great alternations of the brain, of the soma, and of the germen (Part II, Chap. II), to the possible consequences of irregular growth of puberty, which can harm the growth of the cranium in function of that of the

brain, as it harms that of the spinal chord in function of that of the spinal colum (Part II, Chap. I). I point out to you again the law of alternation (pp. 106 and 116), temperament, etc.

Position of the scholar in the schoolroom; necessity of varying it.—In the schoolroom, the respect of the law of alternation interests simultaneously the body and the mind of the child. One of its modalities is formulated in these terms: The sitting posture of the pupil is not a position of repose; the pupil is required to maintain it a long time in immobility, and his reactions show the ill effects of it.

Whatever be the excellence of the combination desk-seat, and we shall see further on that it is far from being excellent, immobility in a fixed posture rather soon becomes a torment for the child, and degenerates into suffering if it is prolonged further. The torment is already manifested by the frequent displacing of the limbs, and of the trunk; it also exerts an influence on attention. The suffering disturbs the physical and intellectual normality of the child, it places the normal state in danger if it lasts too long and in this case acts injuriously on his moral condition.

There are only two positions of repose for man,—the lying position and squatting position (to squat down, to sit on one's heels. Old women squat near the fire).[1] This latter posture is also that of the baby playing in the sand, that of the scholar playing at marbles, that of the Arab on the public square. At *souk* and at the coffee-house, the Arab crosses his folded-up legs and takes another posture which is the position seated on the ground, analogous to that of tailors formerly on their wide table without a support for the back.

[1] Littre.

There is relative repose for the body only in some postures approaching more or less these two positions. The sitting position is intermediate to the lying and the squatting position. It partakes of both, and more of the one than of the other according to the elevation of the seat or the inclination of the back; but it is neither one nor the other and gives no repose if it is not modified in the direction of the squatting position or in the direction of the reclining position.

It is this latter which a person seated on a free seat seeks when he has no fixed point of support for his feet and lifts the forward part of his chair, throwing himself back and so approaching a horizontal position. The scholar corrects in the same way the sitting posture when he lets himself slide down on his chair until his hip-bones correspond to the edge of the seat, his body describing a strong curve at lumbo-dorso-cervical convexity in order to allow its superior part to assume the direction of the back. The child is then said to be "seated on his back" by his parents and his teacher who oppose this position without success.

If the disposition of the seat in relation to the desk, its fixity, the existence of a back almost vertical, do not leave to the child the liberty of "sitting on his back," he does not delay placing himself obliquely on his rigid chair, and thus enables himself to correct in the direction of the squatting position the disadvantages of the angular posture which the furniture imposes on him so that one might call "orthostat," the right angle prevaling at the point of the bi-cotyloid axis of the femur and of the axis of the knees; his body, abandoning the fatiguing rectitude, inclines forward, sinks down, in some fashion, forming a posterior convexity of the vertebral column (hyphosis) which, through the clothes,

appears uniform and greatly curved. On the child stripped, one observes [2] at the level of the lumbar region, a prominence, a veritable hump which is recognized by the spiny processes of the third and fourth lumbar vertebrae, and to which corresponds, in front, a ventral concavity more or less angular whose summit is formed by a furrow-like depression passing through the navel or doubling itself into two folds of which the one rests above, the other below the navel scar.

It happens frequently that the spinal curvature assumes the aspect of a fracture of the column at the level of the prominence of the spinal process (apophysis), above which the column forms almost a straight line, inclined from bottom to top and from behind forward, while below it, the lumbro-sacral portion remains in a vertical plane.

It is necessary that the child feel a quite imperious need of repose to resort to this mixed posture, which is still a fatigue, because it represents only the rude outline of a position of repose and has no other advantage than to relax certain groups of muscles and to displace a trifle the place of pressure.

Either the school furniture suppresses the fatigue of the sitting posture and removes thus for the scholar all cause of seeking a position of repose; or else the school furniture does not suppress the fatigue and then it incurs a heavy responsibility in fettering all the positions of repose, and exposes under this head the scholar to the known effects of daily repeated fatigue.

The remedy is precise and simple: the child must be able to vary his position in the course of studying, in the course of the recitation; he must be enabled to stand up and be seated alternately. The duration of the sitting posture

[2] Dr. P. Godin. *L'attitude scolaire:* l'Educateur moderne, 1906.

is indicated by the approach of fatigue. In virtue of the law of alternation, it is of interest to avoid everything which could cause a transgression of the phases of alternation, a transgression which is injurious for the harmony of the body and which can carry with it a state of illness. Fatigue which is itself born of transgression by too prolonged effort of several phases of repose, implies, once acquired, a transgression of several phases of effort and puts a check on individual activity.

In kind, fatigue appeared on an average in the classes where I have observed and experimented, at the end of 35 to 45 minutes. One should then cause the position to be varied from half hour to half hour. That makes a single change of position in the course of a recitation of one hour.

When the furniture of Féret, of Mauchin of Geneva, of Schindler, even that of Kottman, the optostat of Dr. Rolland of Toulouse, that of Brudenne will be anatomically individualized according to the simple method which I propose, it can be utilized with the greatest advantage, because it facilitates this change of station without trouble for instruction. But it is unusable so long as it is not anatomically individualized.

Once the seat is suitably low there will be left to the legs a freedom of which the muscles and the circulation will have benefited. The erect position will perfect the realization of this beneficent action which will be translated, as experimentation has demonstrated to me, by the substitution of the "euryplastic" for the "macroplastic," by the increase in girth of the lower limbs, in a more just proportion with the growth in length. And one will see fewer and fewer of those poor collegians, "waders," awkward on their too long legs, easily fatigued, a soil too well prepared for all bacillary graftings.

CHAPTER IV

INDIVIDUALIZATION OF SCHOOL FURNITURE

It is "seated" and not "standing" that the scholar makes use of it.—Error resulting from the measure of the scholar's height standing taken as guide in the assigning of a seat.—Height standing and height sitting.—Anatomical and physiological conditions which must govern the choice of individual furniture.—Simple means of conforming to it.—Working manual.

IT is seated and not standing that the scholar makes use of it.—As it is not within the ability of all teachers to have the position varied in the course of school time, and besides as all the instruction does not allow of changes of position, I have attempted to establish between the child and the furniture which is destined for him, a relation as close as possible, to "individualize" school furniture, and I have made it the subject of a long communication to the congress of the *Sociétés Savantes* in 1912 at Paris.

What is "individualization" of school furniture? It is simply adapting it to the child, to the very one who is destined to make use of it. This adaptation can be made only in so far as one takes for guide the anatomy and the physiology of the child in their relations with the sitting posture, a fact which has not been sufficiently taken into consideration up to the present time.

It is indicated, in the first place, that the desk be adapted to the *real* proportions of the *individual, such as they are*

presented in the sitting posture. It is indispensable that this anatomical adapation subsist throughout the changes brought to the proportions of the body by growth.

Up to the present, and that in the whole world, it is stature, that is, the height of the individual in the *standing position,* which has been taken for *guide and for regulation* of all the classifications of school furniture: in England the bi-personal system of Moss offers five sizes. The "single desk" of the United States takes account of eight different sizes. Switzerland, according to the dimensions of Guillaume, accepts eight sizes also. The Belgian Council of Hygiene makes twelve categories according to size. M. Gréard reduced to three the number of sizes according to which desks must be constructed. And it is also size which served as guide for the studies of the School Commission of Hygiene. The latest Congresses relative to the questions of hygiene in schools have formulated no protest at all against this method. And when Cardot, Bagnaux, Fahrner lay claim to some multiple measures, they see them only as complements of the factor height. The optostat of Dr. Rolland answers to three sizes.

Errors resulting from the measure of the scholar's height standing taken as guide in the assigning of a seat.—Height standing and height sitting.—Very precise knowledge of the "P. portions du Corps," [1] of their variations from one individual to another, of their variations in the same individual in travail of growth from one age to another, leave no doubt at all on the absence of fixed correlations between stature and the reciprocal relations *of the segments* which enter into the constitution.

[1] Prof. L. Manouvrier. *Etudes sur les rapports anthropométriques en général et sur les principales proportions du corps.*
Dr. Paul Godin. Les "Proportions du corps pendant la Croissance." *Bulletin de la Société d'Anthropologie de Paris.* Paris, Maloine.

Let us content ourselves, for example, to consider the two great segments, the lower limbs and the bust. By bust, we know, is understood everything which rises above the plane of the seat of the individual seated. The relation of the limbs S to the bust B is only exceptionally the same in two boys of the same height, and, as a necessary corollary, two individuals of equal height in a standing position become of unequal height as soon as they are seated on the same bench. Plate XI.

This fact, so easy to verify, suffices to show to what errors the systematic utilization of height can lead when it is a matter of adapting individually a piece of furniture which the child will use only to seat himself. If, in fact, with Feret, Mauchin, Schindler, Kottmann, Brudenne, it is desired to adapt a piece of furniture for sitting to a standing position, it must undergo a veritable transformation which carries with it a complicated mechanism.

Here is a graph which gives an idea of what becomes of the line of the heads in ten children of thirteen years of age and in ten boys of seventeen years of age according as they are standing or seated. Plate XI. Erect, it is a straight horizontal line; seated, it is a line broken in accordion bellows, as M. L. Manouvrier has demonstrated.

The relation $\frac{S}{B}$, relation of bust (B) to lower limbs (S) governs over the relation of height between the plane of the seat and the plane of the desk top. The distance between these two planes is a result of the value of the relation $\frac{B}{S}$, and it would be indispensable to calculate this relation if it were not found implied in the determination of the fixed distance from the desk top to the eyes.

Anatomical conditions which must govern the choice of

individual furniture.—We must deduce from what precedes: 1. that the size cannot serve as regulation for classification of desks; 2. that two factors are substituted for this unique factor, the limbs and the bust; 3. that each of them concerns distinctly one of the elements of the furniture, the limbs in front to guide in the determination of the height of the bench, and the bust alone being capable of dictating the difference between the seat and the desk top.

So the constructor will have to build some desks separable from their seats, any desk whatever capable of being associated with any bench whatever of the model accepted, the joining and separating (by nuts, for example), capable of being effected with equal facility and rapidity. A high desk will be joined to a low seat and vice versa, following need. The high desk to a low seat will correspond to a *long bust* supported by *short* pelvic members. A seat relatively high, associated with a desk whose top is relatively low, in this sense that its plane is near that of the bench, will be adapted to a scholar of a wholly different structure (macroskeletal), although, perhaps, of equal size, with short bust and long legs. If we name the first of these two scholars X and the second Y, the furniture for X cannot be used by Y, and vice versa, except at the price of discomfort, of suffering perhaps, and, in any case, to the great damage of regularity of development and of capacity for work.

In the course of growth, the respective proportions of X and Y can remain the same, but one must rather expect that each of them will see modified his relation $\frac{B}{S}$ which, very generally, will be shown different according as it will be considered in the same adolescent, before or after [2]

[2] Dr. Paul Godin. *Alternances des accroissements au cours du développement du corps humain.* Société de Biologie, séance du 25 juin 1910, t. LXVIII, p. 119.

puberty. It is because in reality height owes the greatest part of its development, *before* puberty to the *lower limbs*, *after* puberty, to the *bust*, as we established it in studying the laws of puberal alternation. Plate X, A. There will then be cause for repeating the work of adaptation of desks every semester, *every year at least*.

Physiological conditions which must govern the choice of individual furniture. Simple means of conforming to it.— Let us now examine the physiological principles upon which individual adaptation must rest.

(a) The child, the scholar needs to be seated relatively low.

Every fatigued person seeks rest on a low seat, a seat whose edge and plane compress at no point whatever the whole part adjacent to the knee on the posterior side of the thigh. This pressure, to which no one gives heed, is an actual cause of discomfort which produces in the scholar in school time frequent removal of the lower limbs, attributed too exclusively to the "need of movement" of children. In the long run, the compression of the posterior side of the thigh in its inferior third especially, determines some circulatory, nutritive, and nervous troubles, and contributes to the thickness of the shape of the leg compared to that of the Arab's legs, for example; it causes in many adolescents a tendency to fatigue in their lower limbs of which the reason is sought elsewhere, or for which they are reproached as pretext for laziness. Now, a seat suitably low, adapted to the height of the leg of the subject (*without taking the slightest account of his height*) avoids this disadvantage. The suitable height is furnished by the culminating point of the anterior tubercle (tuberosity) of the tibia, so visible on the bare leg of the child, especially of the profile.

(b) The scholar must be able to distinguish on the desk

written and printed characters without having to lean forward, either with the head or the cervico-dorsal spine.

The distance of 35 centimeters between the desk and the eye is necessary and sufficient. Every child with normal sight (emmetropia) or rendered such by corrective glasses, will distinguish clearly the written or printed text, as well as the contour of the letters traced by the point of his pen, if the binocular plane is at 35 centimeters from the point of the desk where his pen is writing. It is advisable then that this distance be reckoned between the binocular line and the center of the desk.

In general, the inclination will be less for short busts for the macroskele (Manouvrier); it will be more accentuated for the long bust (brachyskele). This difference answers to some different correlative proportions of the length of the bust in these two groups; it has for aim to assure the natural support of the forearm on the top of the desk without elevation or lowering of the shoulder, condition of the third physiological principle (c) of individual adaptation.

Such are the notions which, in point of view of individualization, must complete the general rules touching "zero distance," the approved width for the desk, furniture with a single seat.

A consequence of the physiological reasons which demand the low seat, is, besides the foot-rest, the existence of a floor, of a surface extending under the seat like under the desk which the scholar can touch with both his feet in diverse positions which his legs take spontaneously. Another consequence is the adoption of a back such as Dr. Dufestal demands in his school hygiene,[3] "a back slightly inclined and rising to the shoulderblades."

In résumé we desire a bench with a seat in horizontal

[3] Paris, O. Doin, édit., 1910, p. 76.

plane, corresponding to the level of the anterior tibial culmen of the child which must sit there, and supplied with a back slightly inclined and rising to the shoulderblades; the width of the seat will be equal to its height. Desk top inclined more for the long busts (great "difference") and less for the short busts (little "difference"), the center of each desk surface being for each scholar, at thirty-five centimeters below the binocular line (and the other points of the surface, at a distance close to thirty-five centimeters), while permitting the forearm to be placed upon it without inclining the head or trunk or that the shoulder has to be raised.

Working manual.—The working manual designed to determine for each one the appropriate seat and desk will be quite simple.

On the return of the classes, in a room of the building, are ranged on one side some stools of progressively increasing height and numbered from one to twenty, on the other side some desks whose inclination can be varied at will around a horizontal axis passing through the center of the desk top; the height of these tables is different and they are also numbered from one to twenty. These are the trial desks.

The heights of the stools will succeed each other from five to five millimeters and will commence at thirty-two or thirty-three centimeters, in order to end at forty-two or forty-three centimeters if it is in a lycée, with some supplementary numbers above and below for the exceptional cases.

It will be the same for the heights of the desks of this trial furniture which will be graduated from five to five millimeters between fifty-two and sixty-two, for example.

In the aforesaid room, on the day of entrance of the classes, the scholar presents himself with bare knees, dis-

engaged above and below. He passes before the row of stools. The *expert*, supplied with a flat rule, halts the child as soon as the plane of a seat corresponds to the level of the prominence, the anterior tubercle of the tibia. This stool, which is found numbered six, let us say, is taken to a desk. The child seats himself at the successive desks until, his body remaining vertical, the T-square of thirty-five centimeters fills exactly the space between his eyes and the center of the desk top. The desk thus chosen is numbered fourteen. Between the plane of the desk and that of the bench, the difference is large, it is a case of a long bust: we will assume that the inclination of the top should be 18°.

These three numbers 6, 14, 18° are entered on the register opposite the name of the pupil X. The special assistant or workman will join a seat 6 with a desk 14 inclined to 18°.

In the fitting out of the class room, this high desk will be placed toward the rear, the first rows being reserved for low desks, and the seat of pupil X will be located at a point on the classroom floor where a number or the name of the pupil will have been chalked. The procedure is the same for each scholar.

At the first entrance in the classroom, the master having the register under his eye will have the greatest facility in assigning the places without disorder. All this is done very quickly, and assures really individual adaptation of desks, as I have been able to realize by numerous trials in schools.

As to the degree of slope of the desk top, it suffices, empirically, to have the obliquity of the desk varied in the manner that the support of the forearm be secure and easy, the center of the desk top remaining invariably 35 centimeters from the binocular plane.

The scholar is, in this way, in possession of a desk which corresponds truly to his proportions in the sitting position and is conceived in a fashion to follow the changes which growth will cause him to undergo.

The child and the instruction are very greatly concerned in the putting into practice of this so simple process which is a guarantee for the freedom of bodily development as for freedom of mental activity.

CHAPTER V

CONTROL OF PHYSICAL EDUCATION BY THE AUXANALOGICAL METHOD

Account to be taken of growth.—Checking of the effects of exercise with the fixed bar on the development of stature, of the chest, of the pelvis, of the limbs.—Gymnasts and non-gymnasts.—Various causes of abstention.—Conclusions relative to the results of exercise aimed at and to the method of checking.

ACCOUNT to be taken of growth.—We are in possession of a precise method of determining the anatomical conditions presented by a child at a given moment of his growth. In effecting this determination, before applying to him a regime of physical education or a school regime, and in repeating this operation after several months or several semesters of use of this regime, the difference will express clearly the gain realized.

It will be necessary nevertheless to divide this gain between two factors, the contribution of spontaneous growth having been ceaselessly added to the contribution due to the regime followed.

It is at that point that the necessity of the previous study of growth clearly appears, as we have just done, by want of which we should be unable to appreciate better than our predecessors the results of any form whatever of physical education or of an unhealthy condition of development created for the child by the regime which he undergoes.

Let us take for example an exercise for the present out of fashion,—exercise on the fixed bar. The fixed bar was scattered through all the play-grounds of the schools where I have observed, at the disposition of the pupils during recreation. The exercises to which it gave place were veritable *games, made methodical*, however, by the *periodical gymnastic lessons, and thus rendered useful without ceasing to be games.*

In the memoir entitled: "Du rôle de l'anthropométrie en éducation physique" [The rôle of anthropometry in physical education], published in 1901, and which the "Académie de Médecine" crowned in 1912, I translated as well as possible the individual facts into curves. I shall give you only a concise interpretation of them, sufficient, however, to permit you to grasp thoroughly the course of an observation which arises from the experimentation on various sides, and which is shaped by the successive facts. It utilizes the guiding marks accepted in anthropometry and the continuous comparison of children in experiment with an equal number of children for verification.

I should be happy to have you find a guide for your educational or pedagogical evaluations in this practical example of the application of the auxanological method to a matter on which the educator is questioned every day.

Checking of the effects of exercises with the fixed bar on the development of stature, of chest, of pelvis, of limbs. Gymnasts and non-gymnasts.

Stature.—The individual curves I, *I*, of Plate XII, represent two adolescents who started at 143 cm. and reached finally 164 cm. The gymnast grows a trifle higher than the non-gymnast, and attains 1645 mm.

The same fact strikes us when we glance at the following curve. The solid line is constantly as long, longer even

than the broken line; the gymnast, of the same height, at fourteen and one-half years, as the non-gymnast, surpasses him at eighteen years. As long as the difference does not rise above one centimeter, one must, however, consider that there is equality, as M. Manouvrier teaches. This is what takes place for the curves of height I.

The superiority becomes, on the contrary, absolute in groups V and VII, in favor of the gymnasts. Plate XII. The design of the two curves bearing the same number is not the same. The solid line approaches the straight line much nearer than the broken line does.

The comparison of the portions of a solid-line curve with a corresponding broken-line curve gives place to some interesting remarks. From the point of departure, they present some differences of length which are pursued throughout the whole extent of the curve. The components of the solid line have very frequently some lengths almost equal between them; those of the broken lines are of very unequal dimensions.

Between two curves of gymnasts, starting from the same figure, there are often some striking resemblances, and sometimes the figures are the same at corresponding stages. On the other hand, for the non-gymnasts, starting from a common height, no relations of this kind can be established at all.

Leaving aside the details of the evolution and its rhythm, can we not already draw from the individual cases which we have just studied the following deduction? Of two adolescents of the same height at thirteen and one-half years, the one who will attain the greatest height is the gymnast.

The individual cases analyzed are necessarily few, but the same phenomena are observed in almost all those which I possess.

It is here, moreover, that the averages calculated on a

great number of particular curves come to furnish us some notions of such importance that they will suffice to weaken or ground the deduction which precedes.

The averages recorded in A and B have been calculated on 100 individuals, 50 of whom applied themselves to gymnastics, while the other 50 could be considered as non-gymnasts. Plate XIV, A and B.

The line A, height, starting like the line B from 142, attains 163, while the line B stops at 160.

We can now, with great chances of certainty, formulate the following propositions: *Gymnastics with apparatus does not hinder growth. It is even probable that the increase of height in gymnasts is more accentuated than in non-gymnasts.* This is for the adolescent at the period which extends from fourteen and one-half to eighteen years.

Chest girth.—After height, let us examine how chest girth behaves under the same circumstances. The chest circumferences are precisely those of the six subjects whose height we have just studied. Plate XII.

At the first glance, one realizes that the chest girth of the non-gymnasts is totally differentiated from that of the gymnasts. The latter rises regularly, the other irregularly. The latter crosses 15, 17, 20, 21 centimeters. The former increases 10 centimeters, and most often 8, 6 and even only 4 centimeters in the same lapse of time. The development of the thoracic cage takes place in these two circumstances in a wholly different fashion.

In an analysis of the mode and rhythm of growth, we should note that the expansion of the thoracic cage, which is often figured by a number of centimeters greater than that of height, appears independent of the total elongation of the body. It affects a special rhythm which would be interesting to relate to that of the trunk.

But that has only a secondary interest for us at the present time. What is important for us to know is the essential characteristics which mark the difference between the thoracic cage of a gymnast and that of a non-gymnast from the point of view of augmention of girth.

We noted first, as we have just said, the superiority of the total growth of the thorax of the gymnast over that of the non-gymnast. This superiority is much more accentuated than it is for height, and it is common to find a digression of 8 to 10 centimeters at eighteen years between two boys presenting an equal girth at fourteen and one-half years. One can investigate and understand this by examining the perimetric curves with solid line and with broken line of group VII.

The frequency oi plateaus is great in the course of the evolution of the thoracic cage; in the non-gymnasts, these plateaus, more numerous still, affect singularity by their extent. It is not rare to observe the *status quo* during three, four, and even five semesters, as is seen in the broken-line curves of groups V and VII, in children who take no part in gymnastics.

It is necessary to recognize that this is met with also in the gymnasts, but in general at the summit of the curve and not at its base. It is not at all before developing one's self that the stationary period is observed (see the solid-line curves V and VII) but only after having attained a certain fulness, and often the maximum development.

The solid-line curves compared with each other have a sort of group resemblance; their general behavior is characterized by a rapid rising intersected by short arrests followed soon by new thrusts of ascension of great vigor. While the solid lines mount almost vertically, the broken-line curves

approach a horizontal plane; sometimes their upward tendency is almost zero, as in curve V.

Aside from this form of ensemble, which is the expression of a great delay in the expansion of the osseous thorax, the curves of circumference of the non-gymnasts bear no comparing at all between them, so great is the variability of their make-up, so great is their capriciousness. It is evident, then, that the thorax of a gymnast grows more rapidly and reaches a final expansion quite superior to that of a non-gymnast.

The averages calculated on 100 particular cases (50 gymnasts and 50 non-gymnasts) and taken back to one identical original girth, confirm what precedes and permit the formulation of a new proposition: *gymnastics with apparatus procures for the thoracic cage greater amplitude than it will obtain spontaneously* between fourteen and one-half and eighteen years. Plate XIV, A and B.

Weight.—Let us now consider weight in the gymnasts and non-gymnasts, and see what happens while height increases and the body expands. We find an appreciable augmentation of weight on both sides. But, while in the non-gymnast this total augmentation oscillates around 14 kilos, it becomes 20, 25, 27, 29 kilos for the gymnasts.

The form of the curve which expresses the progressive increase of weight holds in some fashion the middle place between the height curve and the curve of chest girth. Plate XII. The greatest analogy is with this last. We find the same vigor of ascent as for height in the weight curve of the gymnast. For the non-gymnast the weight curve models itself in some fashion on the girth curve.

In final analysis, the increase in weight of the gymnast is always superior to that of the non-gymnast. The solid line is constantly longer than the broken line. We are able

to formulate in accordance with the particular cases as in accordance with the averages our third proposition: *gymnastics with apparatus increases the density of the tissues, the weight of the body* of adolescents from fourteen and one-half to eighteen years. The gymnast almost always attains at eighteen years a weight superior to that of the non-gymnast.

Thoracic organs.—Let us see now how anthropometry instructs us upon the modifications contributed by gymnastics to certain partial dimensions of the body of the adolescent, and indicates to us within what limits the relations which these dimensions have between them at the début of the period of experimentation have varied.

Pelvis and thorax.—Let us seek, for example, in what relation the pelvis is found over against the thorax; what are the relations of girth of the lower limbs with the upper limbs. Plate XIII.

Without entering into a minute analysis of fact, we see on reading the curves of group B (average), that spontaneously civilized life, in the college as in the family, favors the development of the pelvis and that of the lower limbs with greater activity than that of the thorax, of the breadth of the shoulders (bi-acromial) and of the upper limbs: the non-gymnasts present a growth of diameter of the pelvis much superior to that of the thoracic diameter as well as of the bi-acromial diameter. In them, the girths of the thigh and calf have a development notably greater than the development of the girths of the arm and forearm.

Averages and individual cases are unanimous and permit in consequence the following deduction: *The lower limbs, at all times urged to action, grow more in volume than the upper limbs in individuals of fourteen and one-half to eighteen years, who apply themselves to the ordinary occupations*

of urban life, of college without practicing gymnastics with apparatus; in them the diameter of the pelvis presents a total growth more considerable than that of the thoracic and shoulder (bi-acromial) diameter. This is what the examination of the curves of group B demonstrates.

If we pass from the non-gymnast to the gymnast, if we glance at the groups A (averages) the quasi-equality of the curves strikes one at once by its very contrast with the inequality of a moment ago. This length of the curves almost equivalent explains the tendency of the thoracic girth and the upper limbs to take a development more considerable under the influence of gymnastics.

We see the circumference of the arm (taken at the level of the biceps) gain almost as many centimeters as the circumference of the thigh. The forearm itself, in spite of arrests, benefits by an increase in volume (girth measured at its maximum) equal to that of the calf.

A simple table will render more obvious the difference of growth of the diameters and circumferences measured, according as one considers them in the gymnasts or in the non-gymnasts.

Superiority in the growth of thoracic organs due to gymnastics.

IN A PERIOD OF ABOUT FOUR YEARS

Lengths of diameter and girth.	Total average growth in centimeters	
	In non-gymnasts	In gymnasts
Diameters		
Shoulder (bi-acromial)	4	6
Thoracic	3	5
Pelvic	6	6
Girths		
Arm	4	5
Thigh	6	6
Fore-arm	3	6
Calf	5	6

In this table are found the figures which are recorded on the curves of averages of groups A and B, which served to construct the table. At a glance one takes in the benefits due to gymnastics for every thoracic part of the body of the adolescent. The same diameters of the thoracic portion of the body are represented by some different figures according as they belong to the gymnast or to the non-gymnast. This remark applies equally to the superior circumferences. Diameters and girths, on the contrary, remain identical or nearly so in the two groups when they concern the pelvic half of the body.

It appears then that we are authorized from now on to lay down the following principle which is deduced from individual facts as from averages.

Equality in growth in volume of the four limbs as well as in simultaneous expansion (transverse diameters) of the thorax and pelvis, tends to be established under the influence of gymnastics in adolescents from fourteen and one-half to eighteen years.

General results.—Let us now turn back and examine in their ensemble the figures and the curves, in order to know if our four propositions express indeed everything which the facts represented in the graphs signify. It is not necessary to pursue the examination long in order to catch a general idea of the greatest importance which is born at all points of the strict observation of facts. This is the regulative action on growth of gymnastics with apparatus.

This exercise, it has been demonstrated to us, does not prevent growing; it seems indeed to favor up to a certain point the growth of the body in length, the elevation of height, in other terms. We have also acquired the conviction that the thoracic cage takes under the influence of gym-

nastics with apparatus, greater amplitude than it would take spontaneously.

We soon find a check on this amelioration in comparison with the enlargements of the pelvis. Spontaneously the pelvis gains in amplitude more than the thorax in an equal time. When gymnastics intervene, the thorax is enlarged almost as much as the pelvis, which does not, however, diminish its development in these circumstances.

The same phenomenon is produced while accentuating itself, when we compare girths of the thoracic members with those of corresponding parts of the pelvis, and the inequalities in progressive growth and in total augmentation between these two groups of organs is attenuated and even sometimes disappears. Gymnastics with apparatus have contributed to the reëstablishing of equilibrium.

This regulative action is explained, on all the curves appended, by the simultaneousness in the increase in height, in girth, and in weight, by the tendency to equalization of the partial developments of the two thoracic and pelvic halves, superior and inferior, of the body.

This action is again manifested by the rarefaction of the times of arrest and the attenuation of the shocks which are produced in the course of the development of the body which assumes the proportions of a general regularity of rhythm of growth.

So many facts are determined which, physiologically interpreted, lead to this conclusion: *Gymnastics with appartus reduce none of the vital phenomena which are manifested by the morphological growth of the organism. Nutritive work and its uniform distribution in the whole economy are energetically favored by this process of physical education.*

So true is this that in matters of physical education "there

are no bad means, there are only bad masters." [1] Here the habitual master has been nature and free imitation. I do not even mention the weekly lesson, whose value for the immense majority is known. Gymnastics have remained play.

The same study is to be made for some other apparatus. But if the fixed bar gives such good results, what has one not a right to expect of apparatus less "congestive," [2] better understood, better adapted to man's aptitude and to his mode of struggle for existence?

Do I need to call attention to the fact that none of the elements of classification which precede, could have been collected without anthropometry? The intervention of anthropometry permits the substitution of precise and correct ideas on the effects of gymnastics for ideas too often false and always vague which have had currency to the present.

Diverse causes of abstention.—"Would not children who do not take part in gymnastics be children constituted in a way relatively disadvantageous from some point of view, and would they not be incapable of attaining, even with the help of gymnastics, a skeletal and muscular development equal to that of children inclined to exercise themselves with a certain violence? Is there not a selection produced from the first attempts which would be encouraging for the vigorous ones "having the stuff" and discouraging on the contrary for the feeble of constitution and of complexion?"

Such is the objection which M. Manouvrier sought to offer me. I thank him for it. This question has in fact a great importance and, in attempting to answer it, I am going to fill up a lacuna of my memory. Yes, incontestably, there is a selection produced dating from the first trials. These

[1] Ph. Tissié: "La fatigue," Paris, 1897.
[2] Ph. Tissié: Art. "Gymnastique."—Larousse.

first trials are in fact encouraging for some, but they are not equally discouraging for all the others. Some of these latter derive benefit from that time on. A greater number leave the apparatus; among these latter, there are some who will return of their own accord, there are some who will require that some circumstance or an order lead them back; some others will remain refractory.

In the ranks of the refractory are found some adolescents described as "weaklings." For these I have prescribed gymnastics as a unique remedy. I can group together fourteen of them, seven of whom have followed my prescriptions while the seven others neglected to follow them. The fourteen were sickly in the same degree, of equally weak temperament (hyposthenic) and of very nearly like proportions, presenting however some characteristics slightly different, so far as I was able to determine. Plates XIII and XIV. I have excluded the adolescents who had even slight deformities, scoliotic or others.

These fourteen weaklings naturally were not included in making up the series of 100. The averages were established for each of these two groups under the same conditions as for the gymnasts and non-gymnasts previously studied.

Let us examine now what observation brings to light on both sides of these two groups of averages presented as previously under the form of curves.

I. *Group: Gymnasts.*—Those rebuffed by the selection of the first lesson were able, although two years older, and of constitution as feeble as on their arrival at school, to take part in gymnastics, succeed in them, and, what is better, to benefit by them to the point of being fit for the voluntary military service at eighteen years.

II. *Group: Non-gymnasts.*—These seven adolescents presented some conditions much like those of the seven who had

submitted themselves to the prescribed gymnastics. But, either by simply capricious stubbornness, or by conceit, or by indifference, or by desire of having himself dismissed from school, each one of these seven weaklings, who did not give in the different acts of their life any signs of laziness more pronounced than their gymnastic comrades, each one abstained absolutely from all gymnastics. In compelling them to play in all the recreations, to take part in all the walks and all the exercises in open air, to receive finally at the infirmary daily a dose of cod-liver oil, I had thought to make up for the gymnastic inaction.

Now, none of these seven non-gymnasts has been able to enter service at eighteen years. All however had reached the regulation height, but presented at the time of enlistment an insufficient chest girth and too light a weight.

I do not believe that the results would remain so absolute with more numerous series than this one. It seems to me nevertheless that these facts bring out with sufficient clearness some connected influences, the influence of gymnastics, and that there is reason to recognize that it exercises on all adolescents a really beneficial action however little assisted it be by bad natural disposition, as is met with, beyond doubt, in sickly subjects.

The selection which is produced dating from the first trials is confirmed by the very existence of this category of weaklings, by the adaptation of some and by the repulsion of others. The cause of this selection is certainly not single. The constitution appears, at first approach, to have a preponderate influence. But a new factor soon appears which takes the lead, under certain circumstances, over the physical constitution. I mean character.

Do we not see, in fact, a certain number of those who had absented themselves from the apparatus at the moment of

their arrival at school, approach the apparatus later under the influence of an apparently insignificant incident, which acted as a determining cause only because it was of a nature to sound the key-note, the fundamental generator of the gamut of adolescent character? Their ardor lasts exactly as long as the determining cause lasts; the initiative is extinguished with the last vibrations of the key-note. It happens that they may have had time to excel in the chosen exercise, although their medium or feeble constitution had appeared *a priori* a sufficient reason for their absention. Then, suddenly, they again become absentionists as before, while conserving the acquisition due to their temporary practice.

Is it not also character which stamps the acts of that other adolescent? He is as little muscled at fifteen years as at fourteen; he is determined however to take gymnastics in his second year of school. Does he act from anxiety to assure his future physical fitness for the voluntary service? Does he not rather have for aim to learn to defend himself, wearied as he is of being victim? His aggressors are for the most part gymnasts, he had noticed, and he desires to become a gymnast to be able to cope with them. Running movements, movements called skilled ("de force") soon possess no longer any secret for him. This weak fellow has succeeded in becoming a gymnast like the strong ones; an imperfect gymnast he is, however, because the dangerous exercises constitute so many unsurmountable obstacles. When he is summoned to execute one of them, he is invaded by an uneasiness vague in its form but of a decisive power of inhibition. He recognizes himself capable of the effort which it demands, he feels the suppleness and the necessary skill; he could take up this movement quite like another; and yet he remains as if rooted to the spot. And he involun-

tarily experiences the reproduction of this phenomenon in the presence of each of the exercises which require some hardiness. He has become a gymnast up to a certain point, but he is as incapable of defending himself as before.

How could one in this case tax the constitution with the responsibility of the abstention of the first hour and not recognize the influence, on this manner of acting, of the character of the adolescent? This example shows again that the constitution is subject to giving way to a mastery which its feebleness did not permit of prediction.

There is then, properly speaking, no normal constitution which cannot adapt itself to the exercises of gymnastics with apparatus. Certain constitutions are more advantageous than others, but none is disadvantageous in an absolute fashion. On the other hand, certain children find in their character the obstacle which the constitution has not opposed to them or the disposition which is their own, and disturbs the practice of a greater or lesser part of gymnastics. In the other exercises, in the games, this defect of character has some analogous consequences, capable of depriving the constitution of some of the best opportunities of fortifying itself.

If there is no constitution refractory to gymnastics, does it follow that all the constitutions derive an equal benefit from their practice? The facts establish that the benefit is relative; in other words, some slender muscles will acquire the maximum development of which they are capable, the maximum force which agrees with their texture without changing this texture which will itself set an anatomical barrier to physiological progress. It is the same with the proportions of the skeleton, and it will be exceptional to see some systems with a delicate frame take on a bulky form under the sole influence of gymnastics.

The relative proportions have been notably improved on the contrary. The curves of weaklings (see p.32) show us that in them, as well as in the precocious gymnasts, the development of the thoracic organs has taken an impetus, unknown up to then, dating from the moment when this special treatment was inaugurated. The thoracic organs of these weaklings have grown almost as much as the pelvic organs. The chest girth and weight have progressed in a fashion quite different and besides considerable in the sickly gymnasts from what they have done in the sickly non-gymnasts.

In a word, if gymnastics have not been able to change the anatomical texture, if they have not been able, save exceptionally, to make some large muscles out of slender ones, they have at least caused these muscles to acquire the greatest power of action which their texture admits of. As to their very indirect influence on the skeleton, it is more easily appreciable at sight in the weak than in the strong, because the muscles of the former cover the bones with a thinner veil, but it is not more marked in the one than in the other.

The effects of exercise on the skeleton merit withal a particular study which will come in its time. While waiting, to rely only on the relative progress of weight, one can note that gymnastics enlarge the skeleton of the strong like the skeleton of the weak in a certain measure.

Perhaps, in the present discussion, one could place himself at another point of view and consider directly the groups formed by the selection which is produced from the time of the first efforts, as M. Manouvrier had forecast.

Let us first cast a glance on the figures entered at the origin of the average curves of the non-gymnasts, and relate them to the same figures of average curves of gymnasts.

These numbers express the averages of measurements taken at the very time when the selection which interests us was effected. Now these numbers are almost equal, which fact indicates already that vigor is not the natural adjunct of one only of the two fields, if one admits at all that the measurements taken be capable of instructing on the vigor of the adolescents observed.

If one proceed by constructing a series of the figures furnished by the individual measurements, and if one take care to repeat this operation for each one of the two groups, it is perceived that none of the two fields offers the homogeneity upon which one would have believed to be able to count, and that, quite the contrary, both present some strong and some weak. Comparison between them of the elements of this double seriation demonstrates clearly that the proportion of the strong and the weak is quite equal on both sides, as well, naturally, as the proportion of the average constitutions.

This direct examination of groups, resulting from selection, which follows the first trials, leads us then to consider as secondary the rôle of the constitution in this selection, which is produced under the multiple influences of which some of the principles have been studied above.

From another aspect, also, this initial distribution provoked by gymnastics is interesting. It furnishes a valuable indication for medical or moral intervention and sometimes for both simultaneously. It is in certain cases a useful auxiliary in the determination of temperaments.

If then gymnastics,—and the few preceding pages seem capable of being summed up thus,—if open air and free gymnastics are no more able to make up the defects of character than to fill up the lacunae of constitutions, they represent at least an exercise within the reach of every individual, a

merit which not all the agents of physical education possess.

One must besides recognize in it an energetic and recommendable action on the general and local development of the organism and regard as applicable to all normal adolescents, without distinction of strength or weakness, the four propositions which I have attempted to establish in the first part of this memoir.

Conclusions relative to the results of exercise aimed at and of the method of checking.

In adolescents from fourteen and one-half to eighteen years, gymnastics with apparatus:

1. Does not injure growth in height.

2. Procures for the thoracic cage more amplitude than it would take spontaneously.

3. Increases the density of the tissues, the weight of the body.

4. Favors actively equality in the increase in volume of the four limbs, in the simultaneous expansion of the chest and pelvis, and in a general manner regulates the vital phenomena which are manifested by the morphological augmentation of the organism.

Let us state also, in formulating it, the method which has been followed for the first time in researches of this kind, and which appears to me of a nature to cause physical education to progress scientifically as a science of improving of the organism applied to the child and to the adolescent:

(a) It is necessary that the study of growth *precede* that of the modifier, the agent of physical education.

(b) To know the lasting, definite changes due to an exercise, it is necessary to make the researches bear on what is the most susceptible of becoming definitive, namely, its remote effects, its results at a distance.

I am convinced that the new French conception of gymnastics, daughter of Richepin's thought and of Greek tradition, the energetic initiative of the naval lieutenant Hébert, will benefit largely from this same auxanological method of control which will put in relief, for each of the pupils of the navy, the vigor developed to the highest degree in respect, throughout the period of growth, of the harmonious lines of human proportions.

CHAPTER VI

ASYMMETRY AND EDUCATION

Half of the body.—Variation of the length of the sternum and rickets.—The shoulders of the child.—Asymmetry of the human body; those things which it is necessary to know by reason of their educative interest.—Probable part taken by the brain in functional asymmetries.—Bimanual education (ambidexterity).

HALF of the body.—If the instrument has measured the total height of the body, divide this height by two and you can have a horizontal plane passed at the height at which the point corresponding to the figure obtained will be found, certain that you are cutting the body into two sections of equal length. This brief operation causes to stand out the difference of the constitution of these two halves and reminds you of what we said of the complexity of the stature.

If you repeat the operation on several persons, you are struck by the different organs in each which the imaginary horizontal median cuts. And if you repeat it on the same child every six months, you will be interested by the displacement of the organs relative to the horizontal median plane, you will be interested to the point that you will pursue the investigation by the measures and multiple notations which you hesitated somewhat to undertake; you will want to know how and why these organs are displaced in the child in travail of growth; you will want to see him grow and understand how he grows, having a misgiving about the influence which

these notions cannot help having on your educative direction.

Variations of the length of the sternum and rickets.— Forthwith this investigation will reserve for you some surprises and will permit you to calm the parents who are tormented by the incurvation of the sternum, which they have ascertained in their child.

Isolated, this concave or convex incurvation is not at all a sign of rickets, but an effect of the irregular parapuberal growth.

Periodical examination of the same child will cause you to witness the resumption of the actual elongation of the sternum which had appeared to be arrested a longer or shorter time. In reality, the great thoracic cartilage had not ceased to grow in length, but the irregular growth having too often in the civilized child, in the city child, in the scholar, broken the parallelism between the spurt of costal elongation and that of the ligaments which fasten the sternum at the two extremities, there has followed an incurvation of the sternum which contrived to mask its real elongation.

From now on, as a result of an opposite evolution, arrest or reduction of the rate of lengthening of the ribs and the conjunctive puberal spurt of growth, the sternum is going to find itself partially liberated, and the observer witnesses from this moment, the straightening of the sternum. He is a witness of this contradictory phenomenon of a cartilage which appears to recover its activity of growth at the very moment when the cartilaginous tissue of the body is struck by arrest or by reduction in its growth. We know that only the effect of straightening is there.

This change in the anatomical disposition of the sternum is correlative of the change of direction of the major augmentation of the lungs, which passes, at the same time (puberty) from horizontal to the vertical plane.

The shoulders.—The disposition shown by the shoulders has a great influence upon the aspect of the silhouette. One notes: high shoulders, low or drooping, average or ordinary, that is, deviating more or less from the horizontal plane and presenting from top to bottom a certain obliquity from the neck to the acromion. The high shoulders themselves only rarely attain a horizontal position. You will consequently note various functional correlations of each of these conformations and I urge you to note them.

Theoretically, the shoulders must be symmetrical. In reality, one of the shoulders is lower than the other; it is the right which habitually occupies the lower plane.

It is understood that you record simply an inequality which your practiced eye causes you to perceive, but I do not ask you to measure it. It would be necessary for that purpose to take the measurements bilaterally as I have done in the course of my researches on growth, and that would go beyond the field to which your complex rôle obliges you to limit yourself.

The inequality of height of the two shoulders is an asymmetry which has been attributed to fencing (Lagrange) and by other authors to a defect of conformation. I have been able to establish that it was a normal asymmetry, and to class it under the head of the functional asymmetries. It results from the activity of the upper right limb, infinitely more intense than that of the upper left.

Asymmetries; their educative interest.—And besides, although the investigation which I urge the educator to make does not bring on a contest with these shades of morphology, I believe I ought to instruct you briefly on the principal asymmetries and their causes. They constitute, in fact, some particulars which are in the medical line, especially, but do not fail to offer for you, educators, a lively interest.

Distribution of asymmetries.[1]—It is sometimes spoken of the asymmetries which the equal organs can present in the normally shaped man; a rigorous method has never, so far as I know, been applied to their determination. I have had recourse to what had been taught me in 1893-1894 by Professor Manouvrier; I have extended it to the two sides of the body on 200 young men; the following are the differences which I was enabled by it to establish between the right and left side.

"1. The upper right limb is larger than the left by a half centimeter.

"2. For the pelvic members, it is, on the contrary, the left which exceeds the right; the difference is a half centimeter, and it is maintained to the level of the calf.

"3. Functional superactivity is then crossed. The more active nutrition which it carries with it must have so much influence on the elongation of the members which are the seat of it as on their augmentation of volume. This is, in fact, what takes place.

"The upper right limb minus the hand (humerus and radius) is longer than the left by one centimeter.

"The lower left limb minus the height of the foot (femur and tibia) is longer than the right by one centimeter. These differences of length hold a proportional part in the segments of the limbs.

"4. Left-handed persons observed constitute a valuable check; in a great number the superiority of volume and of length remains crossed, but in the reverse direction.

"5. The greatest length of the lower left limb in right-handed persons raises the whole corresponding side of the

[1] According to my two notes to l'Académie des Sciences, the first read by Marey in 1900, the second, continuation of the first, read by Professor Laveran ten years later, in 1910.

trunk; the left iliac spine higher by one centimeter reveals the inclination of the pelvis. It is the same with chest girth, of which the left extremity of the scapula exceeds the right by one centimeter on an average.

"6. The left calf, which is the more voluminous, is also lower than the right by nearly one centimeter.

"7. The ears show equally a notable and almost constant asymmetry; on measuring their grand vertical axis, an excess of 5 millimeters in favor of the left ear is found."

The asymmetry of the ears is modified with age in the course of growth; it has a tendency to attenuate itself especially when it was very marked in the little child, or even in the boy or girl before puberty. So a child of thirteen years, whose left ear, for example, is longer than the right, by more than a half centimeter, will see at a given moment, in the neighborhood of the dawn of puberty, its right ear alone grow, the smaller one, which seems to hasten to join the other, which moreover awaits it and does not grow any more. The difference between the two cannot be more than two millimeters at eighteen years. The fact of this unilateral growth is quite individual; I am emphasizing this point to you.

It is a thing to be noted, while taking care not to draw general conclusions from it too quickly, that the twenty-three subjects of thirteen and one-half years, bearers of strong auricular asymmetries were for the most part some "minus habens." Excepting the two who have made their way in life, and two others who have lived "like everybody," there are ten young men endowed with mediocre talent, six lacking talent and three incapables, not only from the point of view of school but also from the point of view of trade. If these last nine are classed in the category of abnormals, in this case, a strong asymmetry of the ears would be met

with in 40 per cent of abnormals. The fact is to be checked up, but it demands the greatest reserve in its interpretation, like all the morphological manifestations of psychical states, moreover.

In my second note to l'Académie des Sciences, I insisted on the variations of asymmetry in the course of growth and its causes. At thirteen years, the right side is superior to the left: in length and in thickness, in the arm and the forearm; in height, at the neck and at the abdomen inferior. Nevertheless the left side prevails over the right side; in length and in thickness, at the thigh and at the leg; in height, at the thorax.

Variations in the course of growth.—Between thirteen and eighteen years, especially, each pair of members, each pair of corresponding segments, either are differentiated more, or conserve almost the same asymmetry: the asymmetries of length of the two forearms, of the two thighs and the asymmetry of the thickness of the two arms are accentuated with age, and realize abruptly an important augmentation at the moment of the appearance of puberty about the age of fifteen and one-half years.

Some semestrial variations characterize on the contrary the inequalities which hold between the length of the right arm (humerus) and that of the left arm, between the thickness of the right forearm and that of the left forearm. In spite of these oscillations, which are in relation with the "alternations of growth" as they spring from my researches, these latter asymmetries are almost at eighteen years what they were at thirteen years.

A comparable stability is met in the neck in the difference of height, to the advantage of the right, of its two lateral halves; the superiority of height of the left hemithorax is in the same case.

The abdomen behaves very differently according as one regards its superior portion, the superiliac or its inferior portion, the interiliac. This latter maintains, in the course of growth, the superiority of its right half; however, for the superiliac portion, the superiority from one semester to another passes from left to right and vice versa.

Causes of asymmetry.—The asymmetries of the thoracic members exist in the new-born. They are measurable. The other asymmetries are not. I mean those of the neck, of the trunk, and of the pelvic members.

The first proceed then from the ontogenetic embryo-foetal elaboration determined, I think, by heredity. The various factors other than heredity do not resist analysis. Moreover, hereditary left-handedness and hereditary ambidexterity are not contested. Why should it be otherwise with hereditary right-handedness?

We are quite certainly in the presence of heredity of a character acquired by the effect of the functional conditions of daily life. A particular circumstance of its evolution seems favorable to this manner of looking at it,—it is its progress throughout age, in an inverse direction from that of growth, but in the very direction of the function. And, besides, do we not see the "consecutive" asymmetries, those of the abdominal members, of the trunk, of the neck, at the genesis of which we were present, proceed although indirectly from the function? to derive from the unilateral localization of manual superactivity?

In effect, it is to be dated from the time when the child stands up and commences to act in a continuous fashion, during waking hours, that the "consecutive" asymmetries appear little by little: those of the lower limbs which subside under the surcharge of the corresponding side, right in the right-handed, left in the left-handed, leave the rôle the

more active, the superiority of the length of bone and muscular hyperplasia, which creates the crossed asymmetry mentioned in my note of 1900. There come again, under the action of this surcharge of the superior right limb, the lowering of the right shoulder, in the right-handed, the sinking of the summit of the right hemithorax, the following up of the first dorsal vertebrae of this same side, with production of an inflexion of the dorsal spine to a left convexity, that is, in an inverse direction to the most habitual pathological incurvation and even to the physiological depression due to the aorta. By compensation, the cervical column becomes convex to the right, and the head remains lightly inclined to the left. Below, the inclination to the right of the pelvis corrects the compensating tendencies of the sub-thoracic segment of the vertebral column.

In the left-handed, these phenomena are reversed. The ambidextrous person does not show them if his bimanual activity is, not special, but general.

Is one not authorized to admit that there have likewise been some asymmetries which it is necessary for us now to consider as primitive, and that they are also born of function? I am forced to this conclusion so much the more because I have seen the different asymmetries more or less completely effaced, without excepting from it those of the superior members, in the adolescents, in whom, aided by some informed educators, I have succeeded in having the habit of bimanual dexterity (ambidexterity) acquired.

Probable part taken by the brain in the functional asymmetries.—Quite recently, a distinguished physician of Cette, Dr. Herber, has proposed as cause of localization at the right of manual superactivity, the place of the heart at the left and the natural tendency to avoid or at least to diminish the injuries which the work of the left arm might cause it.

This seems logical. Clinically, the author establishes some close correlations between the functioning of the heart and the functioning of the superior left limb; the numerous left-handed persons whom one meets do not, however, argue in this direction. The functional activity of the superior left limb which a bimanual education commenced early obtains easily in the right-handed, which I myself have obtained, has not furnished me any occasion to verify any repercussion on the heart.

If the heart were by the place which it occupies at the left, the cause of the above-mentioned localization, left-handedness would have to be the exclusive appanage of those whose heart occupies the right side of the thorax. Now, out of 100 left-handed persons, I have not found a single case of visceral (splanchnic) inversion, of transposition of the heart to the right. I have seen of them only the inveterate left-handed, adults showing no sign at all of degeneracy such as one encounters in great number.

It is advisable nevertheless not to decide against this manner of looking at the question before having observed much. So much the more as this functional correlation between the superior limbs and the heart would perhaps be susceptible of enlightening the question of the part taken by the brain in the functional asymmetries.

A functional localization can possibly imply a cerebral participation. That is doubted by no one. The question is to know if it is a matter of an anatomical modification at the level of the center called to preside over the superactive unilateral function, or indeed if there is on the cerebral side only a state of physiological repose, an educative insufficiency, bearing no injury at all to the cellular condition, and consequently susceptible of being modified by an appropriate education.

In 1883,—Bardeleben had not yet, as much as I know, touched this subject,—I had the occasion to examine two brains of left-handed Arabs, a young man and an old one. A profound study of these two brains showed no trace in them at all of macroscopic anatomical modifications corresponding to the function of the superior limbs.

On the other hand, my different statistics of left-handed persons among the Arabs and the Kabyles, in soldiers of various regions of France, in scholars, of whom I have compared metrically the two hands and the two feet, have never revealed to me a particular state of the less active member susceptible of hindering it at a given moment, from doing as the other member.

Bimanual education (ambidexterity).—In a great number of young people, several days of exercise sufficed to render the left hand qualified to execute the greater part of the useful movements which the right hand alone executed before. At this very time, I have just obtained with a month of exercise in a little left-handed girl of eleven years who is two years from her puberty (see Chapter X), the indifferent use of both hands. It was a matter of a lateral curvature of the spine (scoliosis) by functional asymmetry; the curvature has yielded in four months.

The effect of bimanual education is an excellent argument in favor of the purely physiological participation of the brain in the primordial functional asymmetry of the superior limbs; it tends to demonstrate that left-handedness is not at all a steady sign of degeneration; it is at the same time a valuable pedagogical indication.

In a child in whom the asymmetry of the shoulders appears to accentuate itself with exaggeration, hasten to have the "lazy hand" exercised systematically. If the child is still two years from his puberty, the education will be com-

pleted quickly enough. It would have been still more rapid if the parents had dreamed of habituating their child from the cradle up to serve himself with both hands. You witness the return of a symmetry more or less perfect, in the shoulders, in the upper limbs, in the lower limbs, in the trunk.

This education is quite amenable to the educator. It has nothing special about it, and it endows the child with appreciable resources. According to the results which you will obtain, the physician will make to a certainty the differential diagnosis and will reject all thought of rickets if the symmetries are restored.

You judge by this example of the measure in which you can aid the action of the physician by the processes themselves which give to your educative direction its greatest fulness and its most fruitful influence.

Dr. Livi admits,[2] as cause of the predominance of right-handedness, the first position known by the foetus in the uterus, which results from the place occupied by the intestines of the mother. The superior right limb, finding itself directed toward the abdominal wall of the mother, is free; it has greater ease for exercising itself, and it is the right hand which will act after birth.

I adhere entirely to this physiological conception which leaves to function its predominant rôle and does not eliminate the influence of heredity.

[2] Dr. R. Livi.—"Sulla causa del destrismo e del mancinismo" (Atti. soc. rom. adtropol. 1908, vol. 14, pp. 91-94).

CHAPTER VII

AUXANOLOGICAL INVESTIGATION OF THE SCHOLAR

Anatomical conditions of function.—Form and skeleton.—Their modification by growth.—Anthropometric guiding-marks.

EACH of the educative applications considered in the preceding chapters of this second part have shown that the educator was not free to make simultaneously to several children the application of an educative and pedagogical process, and the absolute necessity for him to individualize the process whatever it be in the physical order as in the intellectual. Nothing then is more natural and besides more logical than now to enter upon the chief object of the educational aims by the analytical study of the development of the child, that is, the determination of his *somatic individuality.*

The individual formula, to which my researches have led me, synthesise sufficiently the somatic individuality at each instant of growth, and that part of the cerebral individuality which is responsible for it.

The gathering up of the elements necessary to the making up of the individual formula is made by means of the processes of observation of the child which we have called "auxanological method," to state in a word that it is periodical, that it follows the same child from semester to semester, that it is anthropometric, not by one, two, or three measurements, but by many, that is, finally physiological and clinical.

Let us study first this process of investigation of the child, after which we shall see how the indications collected must be treated in order to end in making up the "individual formula."

. . . . . .

From each of the general notions, anatomy, physiology, clinic, etc., we shall retain here only the notions indispensable to the knowledge which we propose to acquire. Thus it is that the "form" will be considered solely in function of growth. The analysis of the form of the skeleton is to be studied with special attention, because it is the surest guide for the observer throughout the maze of organs.

Anatomical conditions of function.—With my eminent teacher, Professor L. Manouvrier, I am seeking to grasp *function*, to know its degree of activity and of perfection throughout the anatomical conditions by relying on the anthropometric relations and the correlations. The variations of form as they are shown in the course of growth, aid singularly in interpreting the relations of the surface with depth.

Still, it is necessary that the dimensions of the body be well determined, that its proportions have been exactly calculated, if one desires to search into and understand the modifications which growth carries along with it. That necessitates some fixed guiding-marks which the skeleton will furnish, which is the ensemble of the various pieces supporting the organs, gives them their attachment, constitutes for them a box, a cage or a sheath, procuring for them protection and functional aid.

Also our duty as educator is to have a very clear-cut idea of the skeleton, to know so exactly those of its prominences chosen as guiding-marks that the finger will find them instantly.

Form and skeleton.—Plate XV. It is indispensable that we draw mentally the skeleton through the contours of the teguments of the subject whom we are observing, and that we be in no wise embarrassed to reconstruct it, if instead of an adult, we have to examine a child of whom the parts of the skeleton are among each other in a very different relation from what they are in the adult or even in a child of another age.

With this relation changes the silhouette by reason of the leading influence of the frame on the forms. One is conscious of the modifications undergone by the silhouette with the successive ages of the period of growth, one is conscious of these modifications throughout the digressions of the form, but it is difficult by a simple examination to specify the nature of the modifications.

The only means for us to get a correct idea of it is to utilize the guiding-marks and the measure by the estimate of distances, then to compare between them the relations to which the dimensions noted give place.

The osseous frame determines the skeletons of the human silhouette; it limits also the cavities occupied by the internal organs, by the viscera, so that it is truly the bond of union between the organs of the surface and the interior organs. The skeleton is the support of the locomotive apparatus, which is attached to it and regulates its own dimensions by those of the skeleton. For these various reasons the skeleton will remain the point of support of our observations throughout the successive ages until the end of the period of growth.

The 193 bones of which the skeleton is composed when it is complete and not provided with supernumerary bones, interest us only in so far as they are grouped in organs.

There are thus two cavities and four limbs formed which

we must well understand anatomically in order that the interpretation of their physiological correlations may be easy and certain. The cavities are bounded by bones of flattened form while the limbs are represented by long bones.

In the vertebral column, as at the level of the extremeties, where the hand and the foot are attached to the limbs, one meets a third sort of bone, the short bones. Their rôle is in some respect that of the balls in the wheel-work of certain machines, they multiply the articular surfaces and render more varied, more supple and stronger the play of the hand like that of the foot. The vertebral column also utilizes the short bones, although in a slightly different way; but it is however from the multiplicity of articulations that it derives the marvelous variety of its movements and force.

The articulation permits the bones to assume with regard to each other positions favorable to the movements to be accomplished. They furnish some guiding-marks, some stopping-points for our eye and our finger.

Finally, the greater part of the bones present some apophyses, that is, some prominences, some tuberosities, some kinds of excrescences designed to give attachment to some ligaments and some muscles.

Some of these prominences are excellent guiding-marks for us, the best which could be for the reconstruction of the skeleton and the evaluation of its dimensions.

The two grand cavities are that of the trunk and that of the cranium.

The ribs and the pelvis, joined by the vertebral column, form together a vast reservoir where numerous organs are located. Everyone knows their names. It is their functional rôle which is of importance to us. Now, in their ensemble, they constitute what we can call the "transformer-distributor" of nutrition.

The digestive apparatus transforms what comes to it from the outside into assimilable substance, which the lymph and the blood next distribute to the tissues whose nutrition they thus assure.

The trunk is then a power generating furnace. The neck is the communication between the trunk and the cranium; it is through it that the distribution of nutrition passes up from below and the distribution of nervous force belonging to the brain centers passes down from above. The trunk and the brain fill the rôle of "accumulator-dispenser" of energy.

Above the neck, above that cervical portion of the vertebral column of which one easily sees the isolation from the rest of the skeleton, and supported by it, rises the other cavity, the cranial case.

The whole encephalon is inclosed in it. Below the cerebrum are found, with the cerebellum, the successive convolutions continued downward by way of the spinal cord which descends in the channel of the vertebral column.

It is the cerebrum which occupies the highest part as well as the greatest, and it is the variations of its volume which decide the dimensions of the reservoir which constitutes the cranium.

It is then understood that, when we measure the cranium, we do not measure the brain, but that we evaluate the capacity of a cavity whose dimensions are proportional to that of the brain itself; we have in a way, on the volume of the brain, some information such that we can formulate from the latter an evaluation sufficiently close.

From this shaft of the spinal axis which extends from the hip-bones, the point of support in a sitting posture, to the top of the cranium, and which is designated under the name of bust, are detached four branches at different levels,

but which are all located on the trunk, on the thoracic-pelvic cylinder.

The four limbs offer habitually a twofold symmetry comparable to that which is found in the trunk to the right and the left of the median line, of the axis of the body, of the spinal column.

The limbs are of interest to the educator by reason of their relative length, that is by reason of the proportion which holds between their length and the power of the central vital organs. They interest us again by reason of the resources of which they dispose for action. These resources are manifested by the relative thickness of the bones and of the muscles of a like segment, of the forearm, for example (the segment of the upper limb included between the elbow and the hand).

Anthropometrical guiding-marks.—Let us suppose now that we wish to reconstruct this reservoir, to evaluate the relations which these various parts affect between them; it will from now on be with the meter and no longer with the eyes, and no longer by means of an approximate mental representation that we shall have "to see" the skeleton. Plates XV and XVI.

Let us not forget that it is on the living body that we must find it; it is through the flesh covered with its teguments that we must reconstruct it. Also we shall never have the guiding-marks fixed too accurately, and we shall never be too well acquainted with their disclosures on the living body.

The anthropometric guiding-marks are the following:

The top, the culminating point of the head or vertex.

The point of the prominence which guards the entrance to the auditory canal or point of the antitragus.

The sternal furculum or fork, or the superior edge of the sternum.

The pubis, superior surface of the median part of the anterior bone of the pelvis.

The grand trochanter, the superior edge of the prominence which forms the upper extremity of the femur.

The acromion, the outer end of the process of the scapula which forms an arch over the head of the humerus.

The medius, the lower extremity of the middle finger of the hand.

The guiding-marks which precede are used to determine heights above the ground.

The measure of diameters requires two guiding-marks situated in the same horizontal or vertical plane, except for the antero-posterior diameter of the cranium, where one takes the center of the forehead approximately (at the metopic point) and the point the farthest removed from the occipital convexity. The other guiding-marks of diameters of the cranium are: the most widely separated parietal convexities for the maximum transverse diameter, then, for vertical diameter, the distance from the vertex to the antitragus.

The thorax offers, as level for diameter, the sternoxiphoidian space, the top of the sternum, and it is at this level that the corresponding prominence is sought in the vertebral column.

It is at the level also of the articulation of the xiphoid appendix with the sternum that the space between the lateral convex surfaces of the ribs is determined.

The girths are taken at the level of the maximum thickness, the greatest thickness corresponding to the swell or belly of the muscles, and at the level of the minimum thick-

ness, the smallest thickness of the segment. The minimum thickness answers to the thickness of the bones. These two circumferences are taken on the forearm, according to our individual record card.

The chest girths are taken at two heights. The one passes immediately under the armpits, the other at the level of the articulation of the posterior segment of the sternum (xiphisternum). The form of a truncated cone and the various reliefs of the trunk render these circumferences difficult to take with exactness and almost impossible in the feminine sex.

There are only few advantages in replacing them by the chest diameters.

The extremities, the foot and the hand are well marked by a sketch of their contour. But it is necessary to know how to recognize the head or the anterior extremity of the first and fifth metatarsus, and likewise, in the hand, the second and fifth metacarpus, because the distance which separates them represents the diameter of each of these organs. The extremity from the styloid process of the radius to the wrist, quite easy to recognize, marks the termination of the forearm and the beginning of the hand. The tangential transversal line to the extremity of the finger or of the longest toe marks the end of these two organs. This last is sometimes the great toe, sometimes the second.

CHAPTER VIII

MEASUREMENT OF THE SCHOLAR IN ACCORDANCE WITH THE "INDIVIDUAL RECORD OF GROWTH" [1]

The observation room.—The anthropometric instruments.—Care in checking one's self.—Working manual.—Heights, diameters, circumferences, contours, weight.

OBSERVATION ROOM.—You will realize the indispensable conditions of scientific observation in not fearing to study carefully each of the details susceptible of contributing to your good preparation.

In a room rather small, easy to heat, have a very smooth artificial platform or floor on which the child's feet will not strike any splinters; a platform which assures an even horizontal plane for the soles of the subject's feet and for the lower end of the measuring instrument. If this floor is made a part of the instrument as in the auxanometer, it is unnecessary to have a special one constructed; this is clear gain and is convenient. The measures of height once taken, the platform of the auxanometer disappears with the instrument and does not encumber the floor of the room.

The subject under observation is placed on this platform facing the window. The observer turns his back to the light and sees the child whom he is examining in full light. The secretary, seated facing the light, has before him a table

[1] Dr. Paul Godin, *La Formule individuelle de croissance.* Paris, A. Maloine, édit., 1913, et à l'Institut—J. J. Rousseau. Mensurations pages 2, 3, 5, 6. Notations pages 1, 3, 4, 6, 7, 9, 10, 11, et 12.

whose one end is a half meter from the platform of the instrument, within reach so he can take up from it at need various instruments: the measuring tape, the pen, the caliper, the small metal gauge or the large wooden gauge.

Anthropometric instruments.—The instrument standing alone (it forms a stationary part of the platform of the auxanometer) both hands of the observer are free and can be used in seeking the guiding-marks and for maintaining the child in the position desired in the examination. It is also an advantageous condition for rapidity of execution.

The auxanometer.—The instrument which I constructed suffices for all the measurements which the educator and the physician may have to take. It unites three instruments in a single one: the instrument for measuring vertical height, the instrument for measuring horizontal distance, and the large gauge. The instrument is taken to pieces in two parts. The upper part bears a scale on the side in inverse direction from the total graduation of the instrument, which allows of its being used as a large gauge. Three indicators receive some rods designed to come in contact with the guiding-marks. One of the indicators is fastened at the upper extremity of instrument. It will form the hand-lever of the large gauge in measuring diameters. Of the two other indicators, the one is supplied on the inside with a spring in order to prevent its falling in vertical measurements.

The base of the instrument is furnished with a sheath into which enters an iron rod itself soldered at its lower part to a square plate of the same metal; the rod enters a hole in the platform and the plate goes into a mortise of its dimensions sunk to the lower side of the platform. A shield, surmounted by a thumbscrew, is next passed over the rod in order to facilitate the movement of the rectangular part of the instrument around this axis, which presents at about

midway a groove in which is secured a screw whose head emerges at the surface of the instrument. The tightening of this screw renders the instrument and the metallic pivot firm without impeding the revolution of the rectangle around its axis. The base of the instrument is fastened in the same ways although horizontally to the support which is adjusted at will to one of the extremities of the platform, and permits horizontal measurements of a baby. The horizontal instrument is supported at the other extremity of the platform by a movable piece. A folding stool 30 centimeters in height completes the outfit which in its ensemble has received the name auxanometer from the educator and includes: (1) base of instrument, (2) top of instrument, (3) stationary indicator, (4) movable indicator with spring, (5) movable indicator without spring, (6) rod for the indicator with spring, (7) rod for stationary indicator, (8) rod for indicator without spring, (9) platform, (10) stay, (11) support, (12) stool of 30 cm., (13) metal axis soldered to square iron plate, (14) metal sheath, (15) thumbscrew, (16) key, (17) measuring tape.

The Broca caliper and the metal gauge are utilized only for the measuring of the cranium and the face. The educator and the physician can replace them by the large gauge of the auxanometer which is easier to handle and is without danger for little children.

A pencil unsheathed by boiling water, or a flat pencil, enables one to follow exactly the contour of the foot and of the hand according to Manouvrier's method. If one limits himself to two diameters of the foot and hand, he has recourse to the large gauge. But the contour is very quickly taken, and the graph obtained is a very sure record.

Finally, a place is reserved for a pair of scales capable of weighing at least 80 kilos.

After being assured that the small instruments are at hand, in a way to be able to take them up mechanically, and so being distracted by nothing from the observation of the child, the observer placed as is directed above turning his back to the window and facing the child in full light, proceeds to the measuring. He determines each guiding-mark, and, lowering or raising the indicator, he brings the rod in contact with the guiding-mark, the index finger of the left hand of the operator acting as scout or fore-runner, as well for assuring accuracy of the point of contact as for protectting the skin from the point of the metal rod or of the wooden rule which I have substituted for it for little children.

Each number read on the instrument in hand is called aloud by the observer, and repeated aloud by the secretary, who writes it at the same time and immediately announces the rubric of the following measurement, so that the number called aloud twice is better safeguarded against error.

Care in checking up one's self.—On the other hand, the observer realizes a valuable check, if he is ignorant of the figure obtained in the preceding examination when he takes the new measure.

At the début of each period of measuring, one identical subject ought to be measured two or three times, either the same day or at a day's interval, in order to check up at the same time the hand of the observer and the attention of the secretary, the attitude of the adolescent and the accuracy of the instruments.

I have always taken great pride in having proceeded thus in the course of my measurements in the schools (1891-1901). These experiments presented besides the advantage of being very instructive from other points of view.

The educator and the physician share in the care of taking the measurements and the notations of the individual record. By the individual medical record, the physician will contribute to the direction of education some information of the greatest importance. But if the educator is isolated, if he can assure his pupils the assistance of a physician only in case of illness, then he will do well to add to the measurements all the notations which he will be able to formulate with some guarantee of absolute accuracy.

Working manual. Heights.—The body of the child being quite perpendicular, quite vertical, the observer places the rod of the indicator on the vertex of the subject whom he has had carefully seated on a stool 30 centimeters high; the lower limbs apart and half extended; the body is straightened, a position which is obtained in all, small, large, cultured and uncultured, provided that one knows that the left hand must rest on the spiny prominences of the third and fourth lumbar vertebrae, while the right hand presses on the chin. The straightening is instantaneous and the height seated is taken with great accuracy.

Directly this measure being called and recorded, the child is made to stand up, very erect, heels together but not quite touching and the toes spread. The rod then just touches the vertex where the hair has been parted. This gives the stature.

The observer next places the point of the indicator rod at the point of the auditory canal represented by the culminating point of the antitragus. He rests the pointer on the semi-flat surface which the fork of the sternum (sternal furculum) presents, at the anterior base of the neck. From there, he lowers it to the pubis, whose superior edge at the median part is recognized in depressing a little the abdomi-

nal wall and besides is found very exactly marked by the cutaneous transversal fold which stripes the skin of the abdomen at this point.

The child is then turned three-quarters to the right (this change cannot be a cause of error owing to the platform of the auxanometer), and the height of the following guiding-marks is read:

Acromion, at the sharp external edge of that process which forms the arch above the articulation of the shoulder, but is a little back of the prominence which the head of the humerus forms below.

Medius, at the inferior extremity of the middle finger not including the nail, the hand well extended.

The great trochanter, its superior edge, prominence situated below the prominence of the hip, at the origin of the thigh, at the *same height as the pubis,* several millimeters approximately, outside. One recognizes it by placing both hands on the flat of the thighs at the middle part, then passing the hands up and down while pressing down a little. During this time, the left hand stops the body from yielding to the pressure of the right, and the latter can follow thus the relief of the great femoral process and sinks as soon as the process ceases in the half-flat of the external iliac depression (fossa). The left index finger is placed on the crest of the trochanter in order to guide the point of the indicator with precision.

Another way of proceeding in order to mark the great trochanter is the following: the radial edges of the two index fingers are rested on the right and left hips (iliac crests) of the subject observed. The indexes cross this obstacle and descend while depressing the tissues until the meeting of the trochanter prominence which seems closer to the posterior plane of the thigh.

Diameters.—Following height, it is in order to measure the diameters. The diameters taken directly measure thickness and breadth. The vertical diameters, which are some measures of length, are obtained by the subtraction of two heights. One of them, however, is taken directly. This is the vertical diameter of the cranium.

The antero-posterior chest diameter is taken at the level of the lower extremity of the sternum, which is easily found at the summit of the angle formed by the inferior convergent edges of the thoracic cage, in front. Plate XV.

One of the indicators of the large gauge is applied tangentially to the base of the last bone of the sternum, the other one to the prominence of the spinal process which it meets in the same plane.

The other diameter of the thorax, the transverse, is taken at the same xiphoi-sternal height (Plate XV), the two indicators of the large gauge resting on the costal convexities and binding a trifle. The first time, the diameter is noted when the child is at rest, that is, respires quietly. The second time it is noted when the child has drawn a deep breath and the thoracic cage is expanded to the maximum. It may be useful to take a third diameter just as one of you asked me, the transverse diameter at the moment when the lungs are in forced expiration. It requires, it is true, on the part of the child, a certain degree of physical culture and a special preparation without which he would execute badly the movement of thoracic expulsion.

To the head, Broca's caliper will be applied in front, almost at the center of the forehead, above the arches of the eyebrows, between the frontal mounds (bosses); behind, the other arm will seek the most salient part of the occipital convexity in the same antero-posterior plane. This is the antero-posterior frontal diameter.

The transversal diameter is taken at the maximum, that is, where the compass is open widest in the horizontal plane, higher or lower above the auricle of the ear; farther forward or farther backward according to the individual.

As to the vertical diameter, which represents the distance between the center of the auditory canal and the vertex, it is measured by the steel gauge with its indicator rod taken off. Its stationary horizontal arm is placed on the top of the cranium, the hair being put aside, the graduated arm descends tangentially to the temples; the greatest care is taken of the vertical direction of the descending arm which must be parallel to the axis of the body, then the figure corresponding to the point of the antitragus is read on the scale.

Circumferences.—The circumferences are interesting measurements because they give some information on the thickness of the various parts of the body. Their disadvantage is to vary greatly for a very small difference of level, as well for the limbs as for the trunk.

For the limbs, that is remedied by taking the maximum circumference. It is a matter of raising and lowering the tape measure until there is certainty of the maximum figure, and it is that which is recorded. The same holds for the minimum circumference, which avoids an error of the same kind. It requires the same care to determine exactly the smallest circumference, a fact that necessitates several trials at different heights.

The minimum circumference of the forearm is located above the prominences of the inferior part of the two bones of the forearm, the radius and ulna. The wrist is below these prominences, between them and the hand.

The rubric, "circumference of the wrist," does not fit. It is the "minimum circumference of the forearm" which we

ought to keep as the designation of that measurement, of so much greater importance as it furnishes us the thickness of the bones. Now the bones of the forearm, in the child, are not perceptibly larger at the superior third of the forearm, at the level of the belly of the muscles. So that the difference between their circumference, or the minimum circumference of the forearm, and the circumference of the muscles or maximum girth of the forearm gives us very accurate information on the thickness of the muscles.

Immediately below the elbow, where the forearm is shown to be largest, is found the maximum circumference of this segment.

The investigation of maxima and minima is applicable to the circumferences of the trunk in only an approximate fashion.

It is satisfactory to take the thoracic perimeters at the anatomical point recommended without investigating the maximum and minimum thickness. The horizontal position of the tape measure is carefully watched. For the one measurement, the tape will pass tight against the edge of the armpits, and will supply the circumference under the armpits. For the other, more specially called "thoracic perimeter," the tape will be passed around the body at the height at which the chest diameters were taken, that is, at the level of the inferior extremity of the sternum, described above.

Unfortunately, in children especially, the sternum is still very short and the tape meets at the back the inferior angles of the shoulder blades (or scapulum) and passes bridgelike from one to the other in order to cross the median furrow which corresponds to the spine processes of the spinal column.

There is in these anatomical conditions an important cause

of error. The error is here rendered more serious by this fact that it cannot be evaluated by a constant figure, permitting rigid correction of it; it varies at each repetition of the measurement. It is further accentuated at the time of puberty as a result of the "winged" disposition which the shoulder blades often take, and as a result of the volume which the breasts in young girls take on. These various morphological conditions necessarily disturb the measurement of the circumference of the chest already so uncertain.

You understand, do you not, my tendency to take only very relative account of the thoracic perimeter, and to require of the diameters the reliable information which the circumferences cannot give unless they are multiplied and surrounded by numerous other measurements as they are in my researches?

Contour of the hand and of the foot.—It may be that you have not the desired facilities to take the contour of the hand and of the foot after the excellent method of Manouvrier; it is in that case that you will have to limit yourself to the measurement of the length and breadth of each of these two organs by means of the gauge (compas-glissières), the hand, like the foot, resting flat on a plane surface. I call to your attention the guiding-marks analysed above at the time of the study of the skeleton; for the foot, from the heel to the extremity of the longest toe, for the hand, from point of styloid processes of the radius, which corresponds almost in all to the wrinkle of the bending of the skin on the anterior face of the wrist, to the extremity of the longest finger. As to the breadths, these are the articular heads of the fifth and the first metatarsus in the foot, of the second and fifth metacarpus in the hand which constitute the guiding-marks.

I know that you do not treat these repetitions as negli-

gible tautologies and that you are seizing, with your avidity of knowing all that is useful to the child, these notions which, thanks to our objective, are directly connected to function, and have nothing of the usual dryness of anatomical notions. And it is because you have many times testified your willingness to know the child not superficially, but as profoundly as possible, it is on that account that I do not hesitate to recur apropos the working manual to the important guiding-marks.

As to *contours*, you will obtain excellent ones by taking the following steps: the hand is placed flat, the palm resting on the table, a sheet of paper between. The fingers are extended close together, except the thumb which keeps its natural distance. The middle finger is kept on the prolongation of the axis of the forearm which remains slightly raised.

With the flat pencil, or the round pencil unsheathed by passing it a few minutes into boiling water, the two extremities of the wrinkle of the bend on the palm side of the wrist are marked; or, if one does not desire to have a difference often harmful, embarrassing, between the length of the hand measured in projection and the length of the hand measured on the contour, one marks of the two transversal lines the points of the styloid processes of the radius and ulna. The pencil remaining vertical, traverse next the contour of the hand resting continually its flat surface against the teguments. Next, one separates the fingers one by one except the medius which must remain the fixed axis, and one makes a point at the bottom of each interdigital space.

It is a decided advantage to trace on the external and internal edges, as many transversal, exterior lines to the contour as one perceives articular interlines or extremities of bony processes.

One proceeds in the same fashion for the foot; the con-

tour is registered with a flat pencil after having marked by two transversal lines the middle of both ankles. It is necessary not to fail to follow at each new examination the same procedure as at the preceding examinations. It is obvious that the form of the foot is anatomically more exact, if the weight of the body does not bear on the foot observed. I have always had the weight of the body rest on both feet, as in the regular standing position, during the taking of the contour of each of them, so as to have the foot in its functional state, with its dimensions in the condition of working, as the standing position presents them for each of the body's segments.

Weight of the body.—At the head of the individual record card figures weight. It suffices to know that the weight ought always to be taken without clothing.

The process of weighing the child dressed, then the subtraction of the weight of the clothes weighed afterwards separately, is hardly acceptable for the nursling whom one fears to have take cold. It is quite to be rejected for large children.

This is the way of operating the measurements of a given child, which will always have to be observed, stripped of clothing, supplied at the most with bathing pants.

CHAPTER IX

NOTATIONS TO BE RECORDED ON THE INDIVIDUAL RECORD CARD OF GROWTH

Physiological and clinical setting of the measurements.—The alternations of growth and the semestral period.—Notations to be taken on the child stripped.—Notations to be taken on the child when dressed, among them color of eyes and of hair.—Temperament.—Relation of the duration of repose to the duration of effort.

PHYSIOLOGICAL and clinical setting of the measurements.—Measurements would give only incomplete instruction and would be of a limited utility if they were isolated. They always need a physiological and clinical setting, and the end of the notations is to constitute this setting for them. Among them some are to be taken only once, others are to be repeated half-yearly. The semester is in fact the most practical period and the best suited to the physiological exigencies of observation.

The most of the alternations, I believe I have demonstrated above, can be grasped by the semestral repetition of the observation. Doubtless, when the child is still a baby, it is interesting to follow him more closely, but that matters more for the direction of his health than for that of his education properly called, and the physician will advise in regard to it. The semestral period is always sufficient at the age at which the child attends school.

For each of the notations which the educator is called

upon to take down, I wish to indicate the most practical and rapid mode of evaluation, and yet the most capable to enter with the maximum of precision into the "individual formula," at the time of its being made up.

Notations to be taken on the child stripped.—The child being naked, his "ensemble" is evaluated from the first, and noted by the means of two qualifications: large, medium, small, to which are added stout, puny, massive, slender, strapping, etc.

This notation of ensemble thus extended serves from time to time to illuminate various other notations; it is besides usefully representative. As the ensemble can be modified with progress of growth, the individual card will reserve for this estimate as for all those which are going to follow, the same number of columns as for the measurements.

The "present malady" is to be registered according to the diagnosis of the physician. Likewise, it belongs to the physician to diagnose the signs of the general malady, limited or acquired, the symptoms of nervous affection, present or threatening nervous troubles.

The master will recognize perfectly and will note with the greatest care scars of wounds, traces of blows, of bruises, discolored spots, caused by the effusion of blood into the areolar tissue, or spots violet, bluish, greenish or yellow, their location and their cause with the time when the wound was received.

The remote consequences of traumatisms are not sufficiently known. It suffices to follow the same children, observing them carefully through years in order to understand the whole interest which is attached to intelligent first aid of an even slight injury.

You can always note the asymmetries which will strike you, those of the face in particular. The physician will

also note on his part the defects of symmetry having correlations with various circumstances which his clinical examinations will bring out.

The rubric "additional details," where the asymmetries can be entered, is designed for remarks which found no place elsewhere.

Deformations are the modifications which come in the course of growth such as deviations. Nevertheless the malformations are defects of organic construction which the child bears at birth.

You will be able to estimate the general muscular relief, and for that reason you will have to distinguish the prominences formed by adipose tissue. A child may present reliefs on the calves, on the arms, and possess only very slender muscles. These curves of the surface of the body which imitate the muscular relief are observed in children of the female sex especially, but also in very young boys, and in those who remain more or less effeminate.

It is necessary to distinguish with certainty the "embonpoint" from the "muscular relief," and that is not learned theoretically.

Let us leave to the physician the care of ascertaining the relative development of the genital organs.

You will always be able to note the absence or the existence of hair under the arm, in default of verification of the appearance of it at the pubis, and you will take care to indicate its abundance by the figures from 1 to 5, the figure 1 corresponding to the appearance of the first hairs.

The clinical examination comes next, which is quite entirely in the medical domain. You will record only when the physician and the family communicate it to you, the results of the clinical examination in what concerns the general condition; that by reason of the precautions which it necessi-

tates or of its influence on the intellectual condition and its development. You will also have to take account of the visual and auditory defects pointed out by the technical examination. You will add only to the preceding notes before having the subject resume his clothing, some indications on the color of the skin, on its coloring and on its thickness.

Notations to be taken on the child when dressed.—When the child is dressed, you will be able to attend to the recording on the individual record card of growth, the permanent information, those details which stand at the head, from surname and given name to personal antecedents and to malformations.

You will continue next to note the variable data, the part of these data which can be taken on the child clothed, and which reserve for you the most delicate observations illuminated henceforth by the knowledge which you have just acquired.

The variations of the timber of the voice, of its pitch, the details attending the change, merit mention, as well as the condition of the teeth (good, 3; poor, 1; average, 2).

Before approaching the evaluation of "force" under its various aspects, if it should appear profitable to you to note the color of the hair and the changes which are produced in it, but especially the color of the eyes, I desire to indicate to you the process of observation to which I have had recourse in my researches which have assured me a real precision, and rendered very attractive the determination of the color of the eyes. I transcribe this passage from my work, "Recherches anthropométriques sur la croissance des diverses parties du corps," 1902-03. ["Anthropometric Researches on the Growth of Divers Parts of the Body," 1902-03.]

Color of the eyes.—"Contrary to what has taken place for capillary coloration, the tint of the iris which is that of

the eyes, becomes lighter in 45 per cent of children at the approach of puberty. It becomes darker in only 18 per cent.

" . . . On the whole, in 63 per cent of adolescents, one observes, at the time of puberty, a modification of the primitive coloration of both eyes, while 37 per cent retain the same coloration. . . .

" . . . Sometimes it is a matter of reduction to a single color of the complex primitive coloration, as is found in 23 per cent. Sometimes the change consists only in a modification of the first coloration.

" . . . The method of observation which I have marked out, recognizes at the surface of the iris, of the eye, the small and the large circle: the first peripupillary, inscribed in the second, of constantly homogeneous color, and almost constantly of a darker shade than the large circle from which it is often separated by a border of variable color.

"The large circle, extended from the limits of the first to the border of the cornea, of complex coloration, almost always, as a result of combination of the retro-iris (uvea) pigment with the pigment developed in the very woof of the tissue of the iris, or again, from the only pigment of that woof, composed of grain of different shades, of which some form the dark tint, and others affect some varied dispositions which can all be traced back to the four following forms: stripes, spots, speckles, dots." So much for the color of the eyes.

Color of the hair.—As to the color of the hair, it is to be mentioned without details: red, blond, chestnut, black, with the qualifications light or dark; for it changes in 28 per cent of children. The colors which are modified, are: the dark chestnut 14 per cent, blond 8 per cent, light chestnut 4 per cent, chestnut 1 per cent, and light red 1 per cent.

The colors acquired were black 15 per cent, dark chestnut 6 per cent, light chestnut 2 per cent, chestnut 2 per cent, dark red 1 per cent; two boys recovered after puberty the color of hair which they had before its dawn, having undergone a temporary darkening during the evolution of germen and soma.

In a general fashion, puberty darkens the color of the hair and renders lighter the color of the eyes.

It seems to me that these considerations which I had developed in 1902 were of a nature to interest you and that they merited being presented to you more fully than I had done it apropos of puberal influences.

Possessing so simple a method of observation, you can practice at will the determination of the color of the eyes, and you will arrive at a veritable mastery in that reading from which your educator's ingenuity can very well draw profitable pedagogical effects.

Besides, these changes of color of the eyes are not without physiological and psychological correlations which you will discover yourselves.

Strength.—Let him exercise himself at play, or in some sport, let him wrestle, let him fence, let him take part in gymnastics under any one of its forms, the child will manifest the absence or the presence of these three physical qualities: strength, agility (and elasticity, relaxation) and resistence or relation of duration of effort to duration of repose.

The poorest procedure of evaluation of strength is certainly the dynamometric test whose results are so different according as the child is left to himself or as he is under the influence of a motive of emulation or of stimulation, or again, according as the springs exercise directly their hard pressure on the palm side of the metacarpo-phalangic articu-

lations, or as this pressure is softened by the interposition of a band of padding.

The results finally vary in such proportions between the first trial and that of the eighth day of methodical practice that one is forced to recognize that the figure obtained, in submitting a child once from time to time to the test of the dynamometer, does not represent his absolute strength nor his relative strength.

I propose to you to conclude that a systematic practicing must, as for all other gymnastic exercises, moreover, precede the test of the dynamometer, a fact of which mention ought to be made on the individual record card. The other processes of estimating strength answer to some general qualities less localized.

Temperament.—Temperament has been studied masterfully by Professor Manouvrier in his lessons at l'Ecole d'Anthropologie de Paris. This teacher has had the substance of his lessons published in the Revue Mensuelle de l'Ecole d'Anthropologie, numbers of December 15, 1896, and of June 15, 1898.

Manouvrier considers the temperaments as being represented by the various degrees of nervous potentiality. He distinguishes three degrees; the superior or sthenic temperament, the medium or mesosthenic temperament, and the inferior or hyposthenic temperament.

He estimates that its evaluation must be reduced to the simple appreciation of the degree of nervous energy manifested in certain acts or in the ensemble of the acts of the individuals examined.

We note then the expenditure of energy from 1 to 5, according to the advice of Manouvrier: 3 represents average energy, 5 superior energy, 1 inferior energy; 2 and 4 represent energies very near the average, but which emerge,

4 with a certain superiority, 2 with a relative inferiority. It is thus that since 1893 I have evaluated the quality of energy of the scholars observed at the Ecoles des Andelys, then at St.-Hippolyte-du-Fort, where 300 children had been called more or less energetic, not only according to the information furnished concerning them, but especially according to direct observation of their activity in recreation, on promenade, at military exercise, at gymnastics, and even in class. Each semester added its estimate to the preceding, and I can follow today step by step the modifications of energy contributed by age, growth, education, environment. As elsewhere the variations of these various influences have been noted periodically at the same time as the results of the anatomical, physiological and clinical examination, the organic correlations of each appear in proportion to the working up of them.

I have seen thus constructed the "individual formula" which does not represent a conception more or less happy on my part, but derives from these correlations of facts.

After evaluation of temperament, the educator will note a certain number of manners of being whose combination with temperament can put on the scent of character, this complex synthesis which has not yet been able to be done in a definitive fashion.

It is in this direction that the educator will get information from the parents on the disposition of the child on his awaking; is he sad and taciturn? is he smiling, talkative? is he sulky, authoritative? Indifferent mood will be evaluated 3. If it be sulky, one will record 1; sad, it merits 2. If the disposition is on the contrary smiling, it will be numbered 4, and it will merit 5 if it shows itself exuberantly cheerful.

Relation of duration of repose to duration of effort.— The educator will specify his general estimate of intelligence I, evaluating it from 1 to 5, the figure 5 always marking the highest degree of intellect. Memory can be evaluated separately by the educator, or be joined to I according to the personal manner of considering the question.

A expresses the alternation, the relation $\frac{r}{e}$, that is, the relation of the duration of repose to the duration of effort. The value of *r* and the value of *e* represent some averages of multiple evaluations taken at various times of the day in the course of the different manifestations of the child's activity, somatic (A s) and intellectual (A c).

Meanwhile, you have noted the average conduct of the semester, the average attention.

And now, the individual formula demands of you some calculation destined to furnish the elements which you may need while working at constructing it, but already, by themselves, the results of these calculations instruct you usefully on the length of each of the four grand consecutive segments of height, on the length of the limbs, and of the segments of the limbs, on the length of the bust, on the volume of the cranium, on the volume of the trunk, on the total length of the limbs, the superior added to the inferior, on the volume of the musculature, on the respirational spaciousness.

These calculations are limited to some simple operations of arithmetic, subtraction, addition, multiplication, and division.

For the educator, each of these results is eloquent and representative from the viewpoint of function and of the conditions of individuality. So, these calculations once

made, he will find himself absolutely prepared to construct the individual formula and to interpret it with certainty, with precision in the direction of putting in relief of the somatic individuality, in the direction of the individualization of the direction of education.

CHAPTER X

DETERMINATION OF "SOMATIC INDIVIDUALITY" BY THE "INDIVIDUAL FORMULA" OF GROWTH [1]

The individual formula of growth and somatic individuality.—The individual formula aims at function.—Make-up of the individual formula.—Its interpretation.

THE individual formula of growth and somatic individuality.—The somatic individuality of which we have just given the elements in detail, is, in some sort, synthesized at each moment of growth by the "individual formula of growth." By studying the make-up of this formula we shall grasp the usefulness of our harvest; and we shall see the various interpretations of which each of the factors of the individual formula is susceptible.

The individual formula takes as terms of comparison the volumes of the cranium and of the trunk; the first, because it causes to intervene as factor the capacity of the reservoir of potential energy which is also the center of the "harmonizations"; the other, because it represents the volume of the reservoir in which are found united the viscera which their rôle designates as transformer-distributors.

The individual formula aims at function.—It is that, in fact, the individual formula of growth, through anatomical conditions and relations, refers to the functional relations, such as those of the visceral segments between themselves,

[1] See *La Formule individuelle de Croissance.* Guide for parents, the physician, and the educator. A. Maloine, pub., Paris, 1913.

the functional relations of these with the alimentary tract from the viewpoint of nutrition and energy.

The trunk and the cranium are containers, cases inclosing the viscera. It is of importance, consequently, to estimate their volume. Doubtless their irregular form permits only an approximate estimate; neither of these two cases has, in effect, one of those definite forms of which calculation determines the exact capacity. Multiplication of breadth by depth and of the product by the height will then not give us their true cubic content. When we use, for want of others, the expression, *to cube*, we do not have the pretension of effecting an absolute cubing. We shall seek only and shall obtain relative to the volume of their content, an approximate evaluation which, calculated with the same elements in the various subjects or in the same child at the successive phases of growth, will render the comparison possible and the observed differences extremely instructive; and this is what we must do.

The previous division by a common figure, 3, of all the numbers which have to enter in line for the calculations does not change their relative value at all, and it has the advantage of reducing the quantity of the figures with consequent simplification of calculations.

The make-up of the individual formula and its interpretation from viewpoint of education.—The trunk answers to the transformer-distributor viscera. The digestive apparatus transforms the alimentary substances into nutritive substances; the pulmonary apparatus transforms the venous blood into arterial; the chyliferous vessels distribute to the blood the transformed aliments, the lymphatic vessels come to bathe the tissues, the distribution of the blood is performed by the heart, etc.

The trunk is cubed by the product of the multiplication

of its three dimensions, transverse, antero-posterior, and vertical (this last measured by the distance from the sternal fork (furculum) to pubis or to great trochanter). The product of this double multiplication is called V (Viscera).

V varies enormously from birth to adult age and it is expressed by a different figure at each of the stages of growth, at each of the successive semesters.

It is the same with the product C of the double multiplication of the diameters of the cranium, of which the content is the encephelon, the brain, consequently.

The relation of C to V gives a quotient which instructs us on the relative proportions of the viscera of the vegetative life and of those of the psychic life, as well as on the functional relations of nutritive order between the brain and the soma.

The quotient informs the educator of the free field which the individual vegetative resources for cerebral culture leave to him; it warns him in good time to have to suppress that culture which is given to it at school, and to replace it by an objective culture with the participation of the body; namely, agricultural labor or, in its default, apprenticeship in a trade, as Rousseau recommended; and that, until the organism has acquired some more powerful vegetative resources, or at least more educative resources.

The quotient of the relation $\frac{C}{V}$ at the time of puberty, goes from 20 to 23 in the average child well-balanced and regular. There is there also a valuable warning for the educator.

There is more; the quotient in question, which is 74 in the new-born, advances according to a definite progression toward this average figure 20 to 23. So that, according to its value, one can estimate in a very close way the distance

which still separates the child from the dawn of his puberty.

In order to appreciate, as deserved, information of this order, it suffices for us to recall what growth has taught us touching the "educative moment" of the brain. In making known to the educator the time which must elapse before the dawn of puberty, the individual formula of growth, the relation of $\frac{C}{V}$ especially, permits him to estimate the time which he has to dispose of for the prepuberal culture of the brain.

$\frac{C}{V}$ is to be employed in regard to the evaluation of energy of temperament, in regard to the potentiality whose poverty or richness it can sometimes explain.

As to the expenditure of energy, to its rapidity or slowness, to the importance of the "debit of energy of the child," the educator finds in the relation to V, of another size O (ossature, i.e., skeleton) a very suggestive indication of some inhibitive or auxiliary causes.

O represents the total length of the superior members added to the total length of the inferior members. This is then a linear dimension; and, in certain respects, it may appear singular that it should be taken for numerator of a fraction whose denominator is a volume. But let it not be forgotten that we are here considering function and no longer only the anatomical notion. The distributing function of the visceral trunk is by so much the more laborious as the limbs are longer. The variations of their volume due to causes other than fat have only a little influence on the work of the distributor; the length has, on the contrary, a direct influence, which is interpreted in a precise fashion in the child by the feebleness, the apathy, the fatigableness of the whole organism with repercussion on the ergogenetic function of the nerve centers.

$\frac{O}{V}$ enlightens us on the relative proportions of the total length of the limbs and of the trunk, or, if you wish, on the relation of the trunk to the branches of the human tree.

This quotient instructs us on the probable somatic possibilities. It shows us from what activity of nutrition the motor outfit properly called is provided. It designates for physical education the part of the organism upon which strength-producing action, developing culture must bear. The educator knows, by himself, the extent of the deficit to be made up: if already the relation $\frac{C}{V}$ has demonstrated for us the insufficiency of the child's trunk compared to the average child in his class, and that $\frac{O}{V}$ confirms this notion in showing us the deficit of the trunk in function of the limbs, there is no hesitation possible, it is on the trunk that the solicitude of physical culture must bear, seconded by a combined action on the limbs themselves.

The educator is warned by the two relations $\frac{C}{V}$ and $\frac{C}{V}$ of the individual formula which designate to him the point on which his action must bear; it is for him to act in conformity with this warning if he intends above all to safeguard the regular physical development of the child, if the family leaves him free in his direction of education and if this latter be understood as it ought to be.

Enlightened by the individual formula of growth, one feels how far the progress of a general culture is prudent and advisable, one inquires into and understands the statement of the applications of education, of pedagogy on some points also clearly pointed out.

Soon, the direction thus inspired reaps some encouraging results, education does not delay to have the figures in the

quotient changed in the desirable direction; the transformer-distributor gains in volume, and the limbs no more lengthen only moderately; so that, by degrees, the disproportion is wiped out.

In order to simplify the preceding calculations, I remind you that I divide all the numbers by the same figure, 3, an operation which does not change their relative value at all.

The muscular development is given by the difference between the minimum circumference of the forearm and the maximum circumference of the same segment. This means that, in effect, from the apparent volume of the muscular mass of a limb are to be subtracted the volume of the connective tissue and that of the osseous tissue. The minimum circumference of the forearm equals in an approximate fashion the volume of the connective and osseous tissues. In deducting it from the greatest thickness offered by the forearm, one obtains for difference the thickness of the antibrachial muscular mass, with its vessels, its nerves and cutaneous tissues.

The letter M which expresses it can be considered as representing the muscular volume in function of the osseous volume and $\frac{M}{O}$, the lever power in function of the length of the arms.

The educator has, in fact, as first duty to maintain the equilibrium in V, M, C, a condition of the stability and of the power decreed to the individual, with maintenance of the necessary resources for procreative action.

If one inquires into the respiratory amplitude as the thoracic amplitude construes it in inspiration, one obtains R by subtracting from the transverse diameter of the thorax in inspiration the transverse diameter of the thorax in repose.

One obtains equally a value of R by subtracting the xiphisternal thoracic circumference in repose from the same in inspiration.

In order to avoid all confusion in the work of comparison, we shall call the first Rd and the second Rp.

I am continuing to investigate Rp, in order to permit a comparison of the new results with the mass of the preceding, with the figures of the average child at each age, but I do not neglect the diameters in inspiration, measures to which I urge you to limit yourselves for the anatomical reasons which I set forth to you above.

The value of R lends itself to various considerations, all of which offer a live interest for the educator. However, R (amplitude of respiration) can not rank on the same plane as the preceding notions in the individual formula, because it implies the intervention of the subject, of his good will, as does the spirometer test. There results from it some uncertainty in the estimation of this value and a necessary reserve in its utilization.

Let us note, however, that the averages calculated on a great number of particular cases permit the affirming of the lowering of the rate of respiration, of R after puberty. This fact is susceptible of various interpretations which the educator ought also to be enabled to consider. Does the reduction of amplitude, of R, on the morrow of puberty express a reduction of the activity of respiration? In a *certain measure* there is, in effect, a reduction of the activity of respiration comparatively to the prepuberal activity.

But the largest part of the diminution of R appears to answer to the production of another phenomenon, namely, the "change of direction of the increasing amplitude of the lungs," which, from transverse before puberty, becomes vertical after it.

The educator needs to check this functioning and this substitution, because the *position seated* contributes an obstacle to the play of the diaphragm, to the forcing back by it of the abdominal viscera.

As, likewise, in the *sitting posture*, the position of the superior limbs of the scholar, and the incurvature of the spinal column injure the transverse thoracic amplitude, there is in reality an obstacle in both directions to a sufficient pulmonary amplitude, and it may be that the consequent reduction at puberty is, in part, imputable to these school circumstances.

R is to be followed by the educator, but especially on account of indication and of warning. There is reason to check it by the correlative anatomico-physiological notions and to observe the manner of behavior of each child relative to this value of R and its variations.

The way is open now to all of you who give yourselves sincerely to the observation of the child, to verify the deductions which precede and to multiply the useful applications of the results which the auxanological method furnishes.

BIBLIOGRAPHY [1]

FOR bibliography up to 1901 see "Recherches Anthropométriques sur la croissance des diverses parties du corps."

Paris, 1902-3.

APERT (Dr. E.): *Les Enfants retardataires.* Les actualités médicales. Paris, 1902.

—*Les Maladies familiales.* Paris, 1906.

BARDLEBEN (K. VON): *Weitere Untersuchungen über Linkshändigkeit.* Verh. anat. Gesellschaft. Leipzig, 1911.

—(K. v.): *Statik u. Mechanik des menschlichen Körpers.* Leipzig, 1909.

BIANCO: *Enfants de Madrid.* Revue de l'Hypnot. Fév., 1910.

BONCOUR (PAUL): *Anthropologie anatomique.* Paris, 1911.

BRANCA: *Précis d'Histologie.* Paris, 1906.

BUSCHAN (DR. GEORGES): *Menschenkunde. Ausgewählte Kapitel aus der Naturgeschichte des Menschen.* Stuttgart, 1909.

BUTTE: *Du rôle du médecin scolarie dans l'éducation physique de l'écolier.* Médecine scolaire.

CHAILLOU ET MAC AULIFFE: *Morphologie médicale.* Paris, 1911.

CAPITAN: *Cas d'arrêt de développement.* Médecine moderne, 1893, p. 86.

[1] See appendix to Bibliography, page 236.

Chantre: *Nombreuses communications.* Bulletin de la Société d'Anthropologie de Lyon.

Chaumet: *Croissance des Enfants des Ecoles de Paris.* Th. de méd. Paris, 1906.

Claparède: *La Psychologie de l'enfant.* Genève. 4e édit., 1911.

Collignon (Dr. R.): *Etude anthropométrique des principales races de France.* Bulletin de la Société d'Anthropol. de Paris, 1883.

Combe (de Lausanne): *Körperlänge u. Wachstum der Volksschulkinder in Lausanne.* Zeitschr. f. Schulgesundheitspflege, 1896.

Comby: *Traité des Maladies de l'Enfance.* 1903.

Courtade: *Diamètres thoraciques, leurs rapports avec le périmètre et la surface de section du thorax.* Méd. Scol., 1911.

Cruchet: *La Pratique des Maladies des Enfants.* Paris, 1909.

Daffner: *Das Wachstum des Menschen.* Leipzig, 1897.

Dalché: *Infantilisme régressif par atrophie testiculaire.* Soc. Méd. des Hôp. 7 juin 1901 et *Puberté chez la femme.* Paris, 1906.

Delpeuch (Armand): *Rétrécissement mitral et arrêt de développement.* Société médicale des Hôpitaux. Avril, 1899.

Donaldson: *The Growth of the Brain.* London, 1905.

Dufestel: *Hygiène scolaire.* Paris, 1909 (Thorachomètre de Dufestel).

Dupré: *Développement anormal du système pileux chez les aliénés.* Congr. de neurolog. de Limoges, 1901.

Dupré et Ribierre: *La psychologie de la puberté.* T. I du Traité d'Hygiène de Brouardel, Chantemesse, Mosny et Thoinot. Paris, 1906.

FORGUE: *Précis de Pathologie externe.* 1901-3.

GAUPP, E.: *Die äusseren Formen des Menschlichen Körpers in ihrem allgemeinen Zustandekommen.* Jena, 1911.

GIROUD: *Observations sur le développement de l'enfant.* Petit guide d'Anthropométrie familiale et scolaire. Paris, 1912.

GIUFFRIDA RUGGIERI: *La Questione dei Pigmei e le Variazioni morfologiche dei gruppi etnici.*

GODIN: *De la méthode à suivre dans la récolte des documents relatifs à la croissance chez les différents peuples.* Institut français d'Anthropologie, 1911. *Des lois de Croissance.* Société italienne d'Anthropol. de Florence, 1913.

GONIN, A. ET ANDOUARD: *Uniformité de la croissance chez les jeunes bovidés.* C. R. de la Société de Biologie. Paris, 1911.

GRANCHER: *Traité des maladies de l'enfance.* 1903.

GRASSET: *Traité de Physiopathologie.* Montpellier, 1912.

HALL (STANLEY): *Adolescence.* London, 1910.

HALLS DALLY (DR. J. T.): *Inquiry into the physiological mechanism of respiration.* Journal of Anatomy and Physiology. Oct., 1908, p. 93.

HEUBNER: *Zeitsch. f. pädag. Psychol.* II, 1900.

HIRTZ: *Indice respiratoire.* Journ. des Pratic. janv. 1911 et Presse méd. mars 1911.

HIRTZEL: *Handbuch der Entwickelungsgeschichte des Menschen.* Leipzig, 1910.

HOESCH-ERNST: *Anthrop. psycholog. Untersuchung an Züricher Schulkindern.* Thèse de philosophie. Zurich, 1906.

HOUSSAYE: *La Morphologie dynamique.* Paris, 1910.

JACKSON: *On the prenatal growth of the human body and*

the relative growth of the various organs and parts. Am. Jour. Anat., Vol. IX, pp. 117-165.

KLAATSCH, H.: *Entstehung u. Entwickelung der specifisch. Menschlichen Merkmal.* Wein, 1911. Fortschritte naturwissenschaftlichen Forschung B. III.

KING: *Measurements of the physical growth of two children.* Jour. of Ed. Psy., May, 1910.

LAGOTALA (en collaboration avec E. PITTARD): *Les Kurdes.*

LIEBREICH: *L'asymétrie de la figure et son origine.* Paris, Masson, 1908.

LIVI (DR. RIDOLFO): *Cause du dextrisme et du mancinisme.* Atti della Societa Romana di anthropologia. Roma, 1908.

LOBSIEN: *Schwankungen der psychischen Kapazität.* Berlin, 1902.

LOEB (J.): *Das Leben.* Leipzig, 1911.

LOISEL: "La préspermatogenèse." Congrès de Médecine, 1900.

MANOUVRIER (DR. L.): *Etude sur les rapports anthropométriques en. général et sur les principales proportions du corps.* Mém. Soc. Anthrop. Paris T. II. 3e série 1902, 3e fasc.

MARFAN: *La rachitisme et sa pathogénie.* Paris (actualités médicales), 1911.

MAYET (DR. LUCIEN): *La valeur moyenne du coefficient de robusticité chez les enfants de sept à treize ans d'après 1250 observations et* 5000 mensurations. XXXVme Congrès de l'A. F. A. S. C. R., 1906.

Le développement physique de l'enfant. Etude sommaire des principaux éléments d'appréciation de la croissance normale du corps de l'enfant. Journ. méd. français., Sept., 1912, et 2e. édit. avec 12 fig. et diagrammes. Paris, 1913.

Melzi: *Anthropologia pedagogica.* Arona, 1899.

Montessori: *Anthropologia pedagogica.* (1906 (?)).

Morat et Doyon: *Physiologie humaine.* Paris, 1902 à. . . .

Mac Auliffe et Chaillou: *Morphologie médicale.* Paris, 1911.

Meige: art., *Gigantisme du* P M C.

Mollison: *Die Körperproportionen der Primaten.* Morphologisches Jahrbuch B. XLII. H. 1/2.

Nicolas: *Anatomie descriptive.* Nouvelle édition (de l'Anatomie de Poirier, Charpy et Nicolas). Paris, 1912.

Papillault: *L'homme moyen à Paris.* Bulletins et Mémoires de la Société d'Anthropol. de Paris, 1902.

Pittard et Theraz: *Mandibule et dents en fonction de la capacité crânienne.* Cong. A. F. A. S. Lyon, 1906.

Pittard et Lagotala: *Les Kurdes.* Bull. de la Soc. Roumaine des Sc. Bucharest, 1911.

Ploss, H.: *Das Kind in Brauch und Sitte der Völker.* Leipzig, 1911.

Ploetz (Dr. A.): *Travaux divers in Archiv. f. Rassen u. Gesellschafts Biologie.* Leipzig.

Poutrin: *Contribution à l'étude des Pygmées d'Afrique.* T. XXII, p. 421, et T. XXIII, p. 349. L'Anthropologie, 1911.

Prenant: *La substance héréditaire et la base cellulaire de l'hérédité* in Journ. de l'Anat. et de la Physiolog. No. 1, 1911.

Ranke, J.: *Der Mensch B. I. Entwickelung, Bau u. Leben des menschlichen Körpers.* Leipzig, 1911.

Reche (Dr. O.): *Untersuchungen über Wachstum u. Geschlechtsreife bei Melanesischen Kindern.* Homburg Archiv. Anthrop., 1910.

RICCARDI: *Circonferenza toracica e statura, etc.* Pavie, 1887.

RIVET: *Recherches sur le prognathisme.* L'Anthropologie T. XXI., No. 6.

SCHMID-MONNARD: *Ueber den Einfluss der Jahreszeit u. der Schule auf das Wachstum der Kinder.* Jahresber. f. Kinderheilkunde, 1895.

SCHMID-KUNZ: *Die oberen Stufen des Jugendalters.* Congr. Kinderforsch. Berlin, 1906.

SCHWERZ (DR. FRANZ): *Versuch einer Anthropologisch.* Monograph. des Kantons Schaffhausen. Denkschriften der Schweiz. Naturforschenden Gesellschaft, B. XLV.

SCHWERZ (DR. FRANZ): *Untersuchungen über das Wachstum des Menschen.* Arch. f. Anthropol. N. Folge. B. X., p. 1 à 38.

—*Ueber das Wachstum des Menschen.* Bern, 1912.

SERGI: *Origine et expansion de la race méditerranéenne.* Leipzig, 1897.

SIGNORELLI: Il diametra vertebrale. Atti Societa Romana Anthropol., 1908. Vol. 14, pp. 219-238.

STIER, E.: *Studien über Linkshändigkeit. Monatschrift Psychiatrie u. Neurologie,* B. 25., H. 5.

STRATZ: *Wachstum u. Proportionen des Menschen vor. u. n. der Geburt.*

—*Wachstum u. Proportionen des Foetus.* Zeitschrift Geburts u. Gynäkologie.

—*Atavismus des menschlichen Ohres.*

—*Ueber die Normalgestalt des Menschen.* 6 fig.

—*Grösse u. Proportionen der menschlichen Rassen* in Arch. Anthropol. N. Folge. B. 8 et B. 10.

TESTUT: Traité d'Anatomie humaine. 3600 fig., 6e edit. Paris, 1911-12.

Testut et Jacob: *Anatomie topographique.* Paris, 1912.

Variot: *Traité d'Hygiène infantile.* Paris, 1909.

Variot et Lassablière: *Sur l'inégalité de volume des glandes mammaires chez la femme.* (Acad. des Sciences. Juillet, 1908.)

Variot et Chaumet: *Croissance des Enfants des Ecoles de Paris.* 1906.

Varigny (H. de): Article *Croissance (Zoologie)* du Dict. de Ch. Richet.

Vialleton: *Eléments de Morphologie des Vertébrés. Anatomie et Embryologie comparées.* Paris, 1911.

Viola: *Le Leggi di correlazione morfologica dei tipi individuali. Lavori del Inst. di clinica medica gener. dell. Universit. di Padova.* Vol. IV. Milano, 1909.

Volkow: *Variations squelettiques du pied chez les primates et les races humaines.* Bull. et Mém. de la Soc. Anthr. de Paris, 1901-1903.

Wagner, W.: *Entwickelung des Kinderkörpers von der Geburt bis z. Abschluss des Wachstums.* Hanovre. Ver. Züchtungsk., 1911.

Weissenberger: *Das Wachstum des Menschen nach Alter, Geschlecht und Rasse.* Globus XCIV, 22 graph. Tab. und 2 Taf. Stuttgart, 1905.

—*Die Köperproportionen des Neugeborenen.* Jahrbuch f. Kinderkeilkunde, 1906.

—*Das Wachstum des Menschen. Studien u. Forschungen zur Menschen und Völkerunde VIII.* Stuttgart, 1911.

APPENDIX TO BIBLIOGRAPHY

ANTHONY, R.: *Anthropologie physique* in *Traité d'Hygiène de Brouardel*, Chantemesse et Mosny. Paris, 1906.

BLANCHARD, R.: *Bulletins de l'Académie de Médecine.*

BOAS (FRANZ): *The Growth of Children in Science*, Vol. XX, 1892, and new series, Vol. V. New York, 1897.

DENIKER, J.: *Quelques observations et mensurations sur les Nubiens qui ont été exposés à Genève en Août, 1880.* Bulletin de la Société d'Anthropologie, 1880, p. 594.

—*Races et peuples de la terra.* 1 vol. Paris, 1900.

—*Essai d'une classification des races humaines.* Bulletins de la Société d'Anthropologie, T. XII, p. 320.

GLEY: *Physiologie humaine.* Paris, 1910.

HRDLICKA, A.: *Physical difference between white and coloured children of the same sexes and the same ages.* 1898.

HRDLICKA, A.: *Report on anthropological work in the State Institution for feebleminded children*, Syracuse, N. Y., 1899.

—*Physiological and medical observations among the Indians of southwestern United States and Northern Mexico.* Smithsonian Institution, Bureau of American Ethnology, Bulletin 34. Washington, 1908.

LAGOTALA: *Compte rendu sommaire du XIV^e Congrès international d'Anthropologie et d'Archéologie préhistorique.* (Genève, Sept., 1912), in *Bulletins de la Société d'Anthropologie de Lyon.*

LE DOUBLE: *Traité des variations du système musculaire.* Paris, 1897.

LE BON: *Recherches expérimentales sur les variations du cerveau et du crâne.* Bulletins de la Société d'Anthropologie, 1878.

LOTH (DR. ED.): *Observations anthropologiques sur le système musculaire des nègres.*

MARTIN, R.: *Anthropometrische und Craniometrische Technik.*. Zurich. Füssli, 1903.

MOCHI (PROF.): *Bulletins de la Société Ital. d'Anthropologie de Florence.*

PAUL-BONCOUR (DR. GEORGES): *Le Fémur.* (Prix Broca.). Paris, 1900.

—*Anthropologie anatomique;* crâne, face, tête sur le vivant. Paris, 1912.

PITTARD: *La taille, le buste, les membres supérieurs et inférieurs chez* 121 *Tziganes des deux sexes* (783 hommes et 430 femmes étudiés principalement dans la Dobroudja). Bull. de la Soc. des Sc. de Bucharest, 1906.

—*Influence de la taille sur l'indice céphalique.* Bull. de la Soc. d'Anthropol., 1905.

—*Analyse de quelques grandeurs du corps chez l'homme et chez la femme.* Bull. des Sciences de Bucharest, 1906.

RADOSAVLJEVICH (PROF. PAUL R.): *Professor Boas' new theory of the form of the head,*—a critical contribution to school anthropology. Lancaster, Pa., U. S. A., 1911.

—*Die Entwicklung des Kindes Innerhalb der Schuljahre.* Eine Skizze aus der Experimental-Pädagogik. Monatshefte für deutsche Sprache und Pädagogik, 1912.

Regnault, F.: *Bulletins de la Société d'Anthropologie*, 1902-1912.

Retzius: *Ethnologische Schriften.* Stockholm, 1864.

Virchow: *Archiv. f. Anthropologie*, T. IV, 1871.

Weissgerber: art., Bouche, Front, Barbe du *Dictionnaire des Sciences Anthropologiques.*

GLOSSARY

A

acromion. The triangular-shaped process at the summit of the scapula that forms the attachment of the deltoid muscle.

amygdala; pl. –lae. 1. The tonsil. 2. A small lobule on the lower surface of each cerebellar hemisphere projecting into the fourth ventricle.

anthropology. The science of the natural history of man.

anthropometry. Art or practice of measuring the different parts of the human body and of determining their mutual proportions.

aponeurosis; pl. –ses. A fibrous membranous expansion of a tendon giving attachment to muscles or serving to inclose and bind down muscles.

apophysis; pl. –ses. Any process, outgrowth, or swelling, especially a bony process that has never been entirely separated from the bone of which it forms a part.

arachnoid. A delicate membrane interposed between the pia mater and the dura mater of the brain and the spinal cord.

arthralgia. A neuralgic pain in a joint.

arthritis. Inflammation of a joint.

auxanalogy. The study of growth according to the auxanalogical method.

auxanometer. An instrument which unites the diverse means of auxanalogical measurements.

B

biacromial. Pertaining to the acromion.

bicotyloid. Pertaining to the two rounded cavities, one in each of the innominate bones which receives the head of the femur.

binary. An anatomical term meaning separating into two parts.

bitrochanteric line. A line extending from one trochanter major to the other. *See* trochanter.

brachyskeletal. Brachy, a prefix meaning short; hence a short skeleton or frame.

C

chondroblastic. Pertaining to chondroblast, a cell of developing cartilage.

D

dartos. The contractile musculofibrous layer beneath the skin of the scrotum.

distal. "The terms proximal and distal should be applied only in the description of the limbs. They denote relative nearness to or distance from the root of the limb. Thus the hand is distal to the forearm, whilst the arm or brachium is proximal to the forearm."—Cunningham.

dura mater. The outermost, toughest, and most fibrous of the three meninges or membranes of the brain and spinal cord.

E

ectoderm. The epiblast or outer layer of the primitive (two layered) embryo.

ectodermic. Pertaining to the ectoderm or derived from it.

embryogeny. The formation of the embryo and its course of development. *embryogenic*, a.

embryology. The department of biology which relates to the formation and development of the embryo in animals and plants.

ergogeny. The energy, both potential and kinetic, involved in the adaptive processes of living organisms.—Gould.

ergogenetic. Of the nature of or pertaining to ergogeny.

F

furcula. A furcate process or projection.

furculum. A forked elevation in the floor of the embryonic pharynx.

G

gangue. An amorphous intercellular or enveloping material.

germen. The reproductive element considered in its essence.

gigantism. Total, is an exaggeration of all the dimensions of the body; if the exaggeration is only in one part, the gigantism is segmentary.

H

hyperplasia. The excessive deposit or augmentation of the elements of the tissue composing an organ.

hypertrophy. An increase in the size of a tissue or organ independent of the general growth of the body.

hypophysis. The pituitary body; called, more fully, hypophysis cerebri, that is, a small, reddish-gray vascular body weighing about ten grains, contained within the

sella turcica of the skull. It consists of two portions—the anterior and the posterior. The anterior is derived from the oral cavity, the posterior descends as an outgrowth of the brain.

hyposthenia. Weakness; subnormal strength. *hyposthenic,* a.

I

iliac spine. Spine of the iliac is a point or process projecting from the ilium.

ilium. The superior broad portion of the innominate bone.

interstitial. 1. Situated between important parts; occupying the inter spaces or interstices of a part. 2. Pertaining to the interstitial or connective tissue.

ischio-pubic. Relating to the ischium and the pubis.

ischium. The inferior part of the os innominatum; the bone upon which the body rests in sitting.

M

macroskeletal. Monstrosity consisting in excessive development of the legs.

meninges. The three membranes that envelop the brain and spinal cord, including the dura, pia, and arachnoid.

mesatiskeletal. Average bust relative to the lower limbs. The mesatiskeletal comprise the proportions of the greatest number of persons, the majority.

myeloplax. One of the large multinucleated cells found upon the inner surface of bone and concerned in its absorption.

myopathia; pl. –ias. A disease or morbid condition of the muscles.

myopathy. *See* myopathia.

N

neoplasm. A circumscribed new formation of tissue characterized by abnormality of structure or location. As generally used the term includes all true tumors, as well as tumorlike growths due to micro-organisms, as the gumma and tuberculous tumor.

nubility. The state of sexual development when marriage may be consummated.

O

ontogeny. A term used to denote the development of the individual organism.

osteogenetic. Pertaining to osteogenesis.

osteogenesis. The development of bony tissue.

P

pathogenetic. Having the power to produce disease; a term applied to micro-organisms capable of exciting disease.

pathological. Morbid; due to disease.

periosteum. A fibrous membrane investing the surface of bones, except at the points of tendinous and ligamentous attachment and on the articular surfaces, where cartilage is substituted.

phylogeny. A term used to denote the evolution of a group or species of animals or plants from the simplest form. The evolution of the species as distinguished from ontogeny, the evolution of the individual.

pia mater. The innermost and most vascular of the three membranes of the brain and the spinal cord.

prostate. The organ surrounding the neck of the bladder and beginning of the urethra in the male.

ptosis. Drooping of the upper eyelid due to paralysis or atrophy of the levator palpebrae superioris. The term is also applied to abnormal depression of other organs.

pubis. Pertaining to the pubic bone; that portion of the innominate bone forming the front of the pelvis.

S

scoliosos. A morbid lateral curvature of the spine.

scoliotic. Pertaining to or marked by scoliosis.

serous membrane. The lining membrane of any one of the great splanchnic or lymph cavities.

soma. 1. The body alone, considered without the limbs. 2. The entire body with the exclusion of the germ cells.

somatic. 1. Pertaining to the body. 2. Pertaining to the framework of the body and not to the viscera.

spermatazoon. The motile generative element of the semen which serves to impregnate the ovum.

splanchnic. Of or pertaining to the viscera; visceral.

sternal furculum. Pertains to the semilunar notch of the sternum, also the notch of the ensiform cartilage when it is cleft.

sterno-xiphoidien. Pertaining to the sternum and the ensiform cartilage.

T

thalamus opticus. A mass of gray matter at the base of the brain developed from the wall of the vesicle of the third ventricle and forming part of the wall of the latter cavity. The thalamus receives fibers from all parts of

the cortex (of the brain) and is connected with the tegmentum and with fibers of the optic tract.

tic. A twitching, especially of the facial muscles.

thymus. An organ situated in the anterior superior mediastinum. It continues to develop until the second year of life, afterward remains stationary until about the fourteenth year and then undergoes fatty metamorphosis and atrophy.

thyro-arytenoidal (ligaments). Two ligaments (one on either side) extending from the thyroid cartilage dorsally to the arytenoid cartilage which constitute the supporting ligaments of the true vocal cords.

traumatism. The condition of one suffering from injury.

trochanter (great). One of the two processes on the upper extremity of the femur below the neck.

V

varices (pl. of varix). A dilated and tortuous vein.

X

xiphisternal. Pertaining to the xiphisternum.

xiphisternum. The ensiform process or third piece of the sternum.

Z

zygomatic arch. The arch formed by the zygomatic process of the temporal bone and by the malar bone.

CHARTS

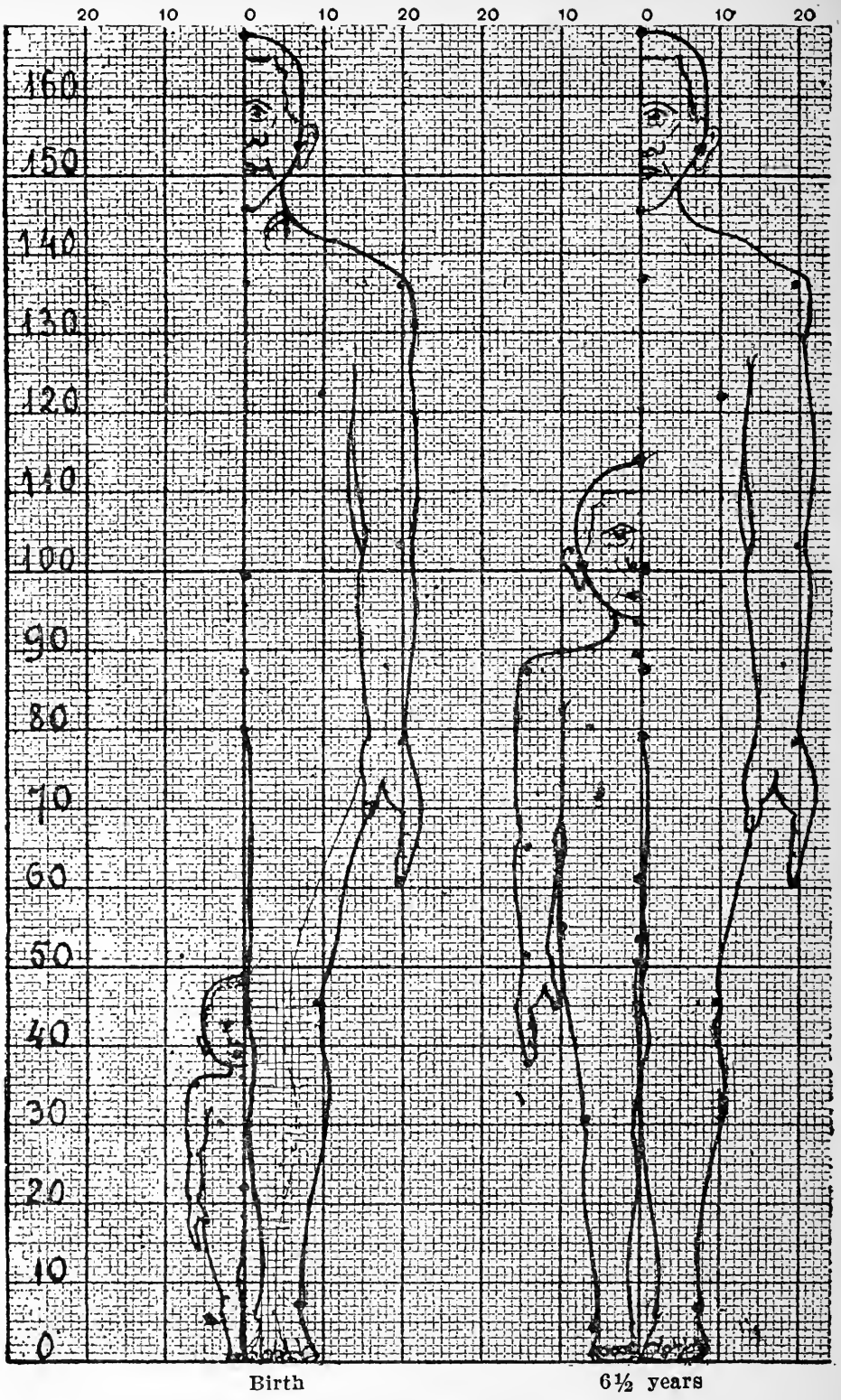
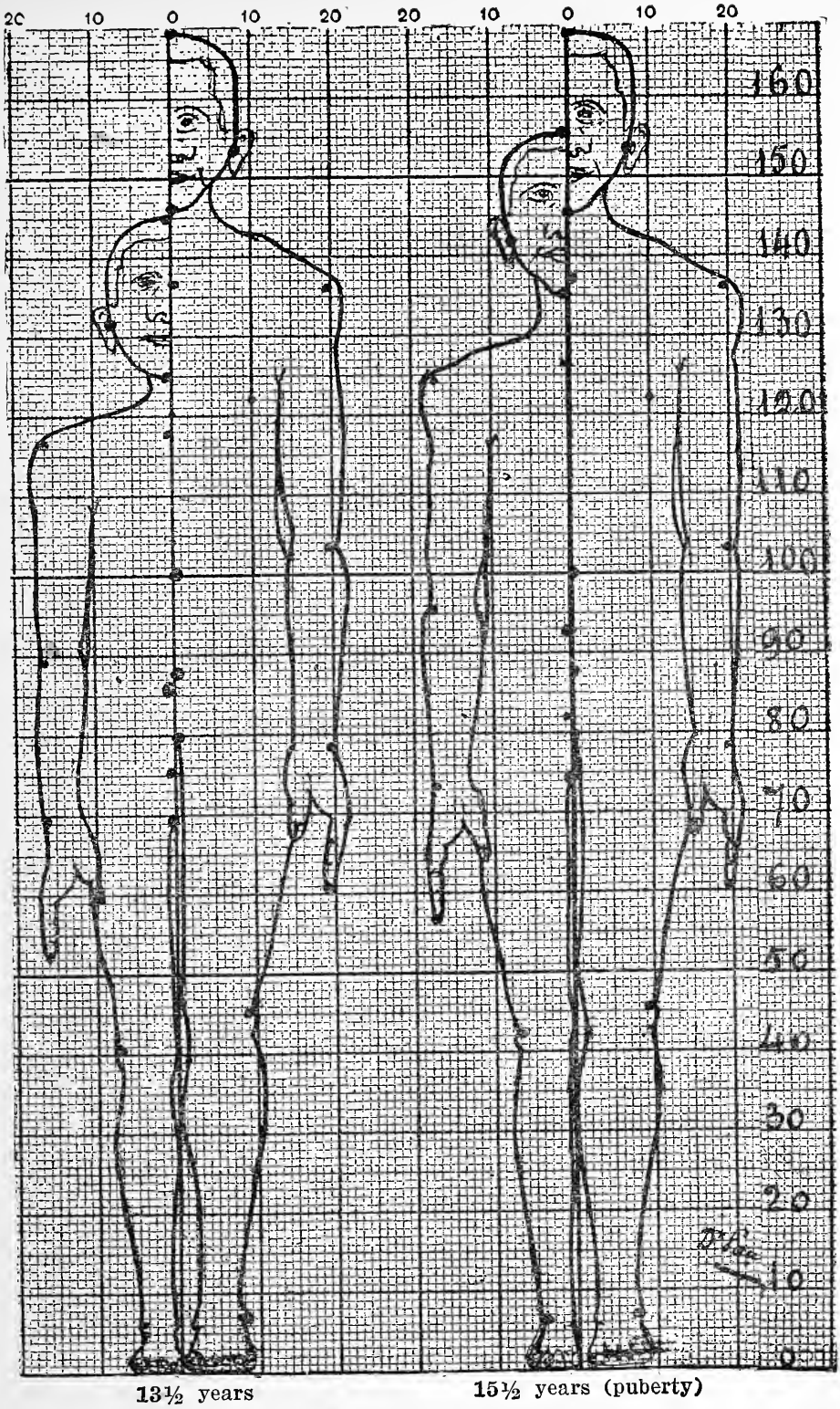


PLATE II.—Growth (absolute growth) the Ages of



13½ years 15½ years (puberty)

Evolution compared to adult age.

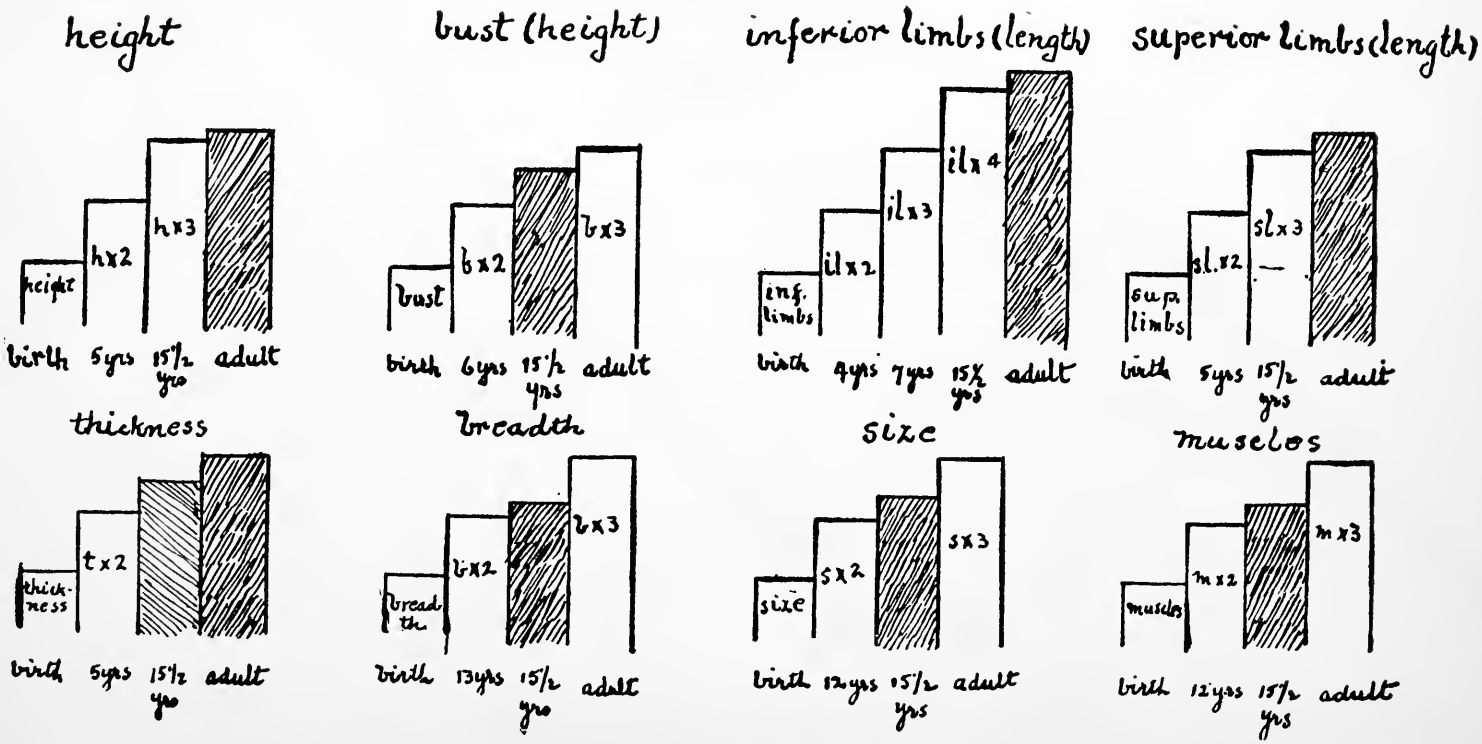


PLATE III.—Growth of the diverse dimensions of the human body (*solide humain*). Ages at which they double, treble, quadruple not shaded.

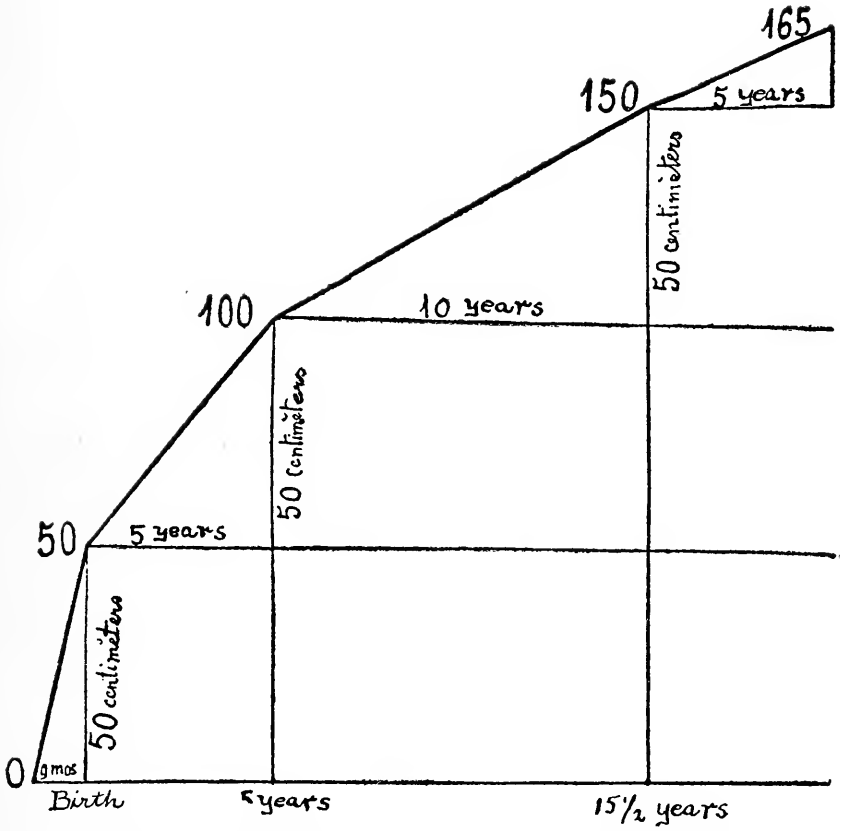


PLATE IV.—STATURE. Rhythm of its elongation.

Legends of Plates V, VI, VII, and VIII

a Vertex, culminating point of cranium.

b Maximum transverse diameter of the cranium, at its approximate place between the vertex and the auditory canal.

c Auditory canal.

c' Bizygomatic diameter drawn in the plane of the auditory canal, but which, in reality, is on an average, 10 mm. above the center of the auditory canal.

d Chin, median point on the inferior side of jaw.

e Diameter of the neck, middle point.

f Sternal fork.

g Acromion, external edge where the upper limbs are attached.

g' Biacromial diameter.

g'' Bihumeral diameter, continuing beyond the acromion, the biacromial diameter.

h Nipple.

h' Bimammillary diameter, distance of the centers of the two nipples.

i Inferior extremity of the sternum (sternal crest), xiphisternal articulary space.

i' Transverse diameter of the thorax at the level of the xiphisternal space.

k Waist, minimum diameter.

l Elbow, humero-radial articulary space, the greatest bicondyloid breadth is 20 mm. above.

l' Bicondyloid-humeral diameter.

m Umbilic.

m' Bisiliac diameter, maximum separation of the iliac crests (almost in the plane of the umbilic).

n Iliac spine.

n' Bispinal iliac diameter, distance between the centers of the two antero-superior iliac spines.

p Great trochanter, superior extremity.

p' Bitrochanter diameter, is here elevated by two one-hundredths on an average, the greatest breadth measured being 25 mm. (13½ years) and 35 mm. (23½ years) above the superior edge of the great trochanter.

q Pubis, superior edge of the pubis (public symphysis).

r Ischium, joined to the great trochanter by an oblique dotted line (process of the ischium).

s Wrist, point of styloid apophysis of radius.

s' Bicondyloid anti-brachial diameter, the greatest bicondyloid breadth is 8 mm. on an average above the extremity of the styloid apophysis of the radius.

t Medius.

u Knee, articulary space.

u' Bicondyloid-femoral diameter, the greatest bicondyloid breadth is 23 mm. on an average above the articulary space.

v Internal ankle, lower extremity.

v' Bicondyloid ankle diameter, the greatest bicondyloid breadth is 8 mm. on an average above the tibial ankle point.

x Seventh cervicle.

x' Summit of the sacrum.

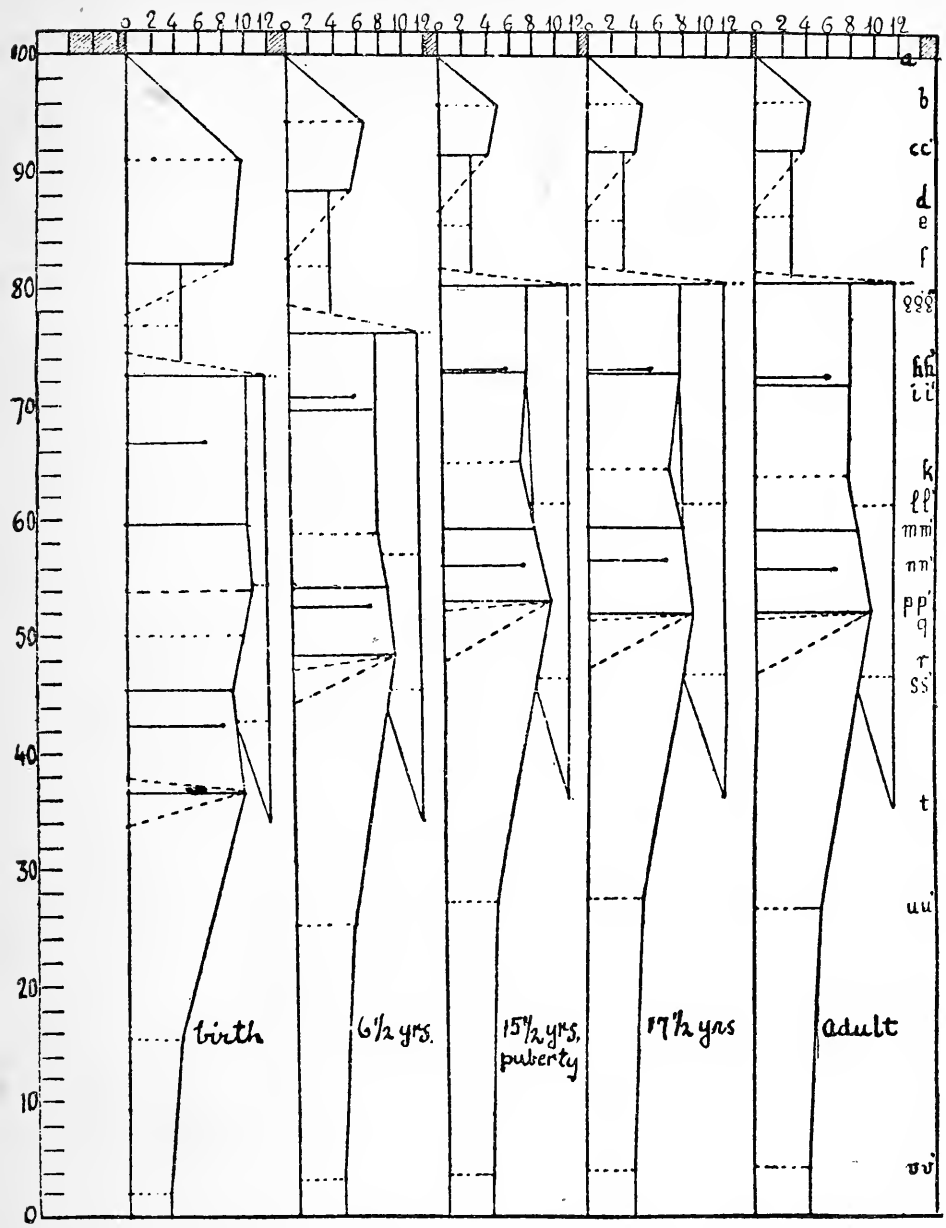


PLATE V.—The ages of evolution related to adult age. Rélative growth (total and segmentary).

(Plate reproduced by courtesy of the Anthropological Society of Paris.)

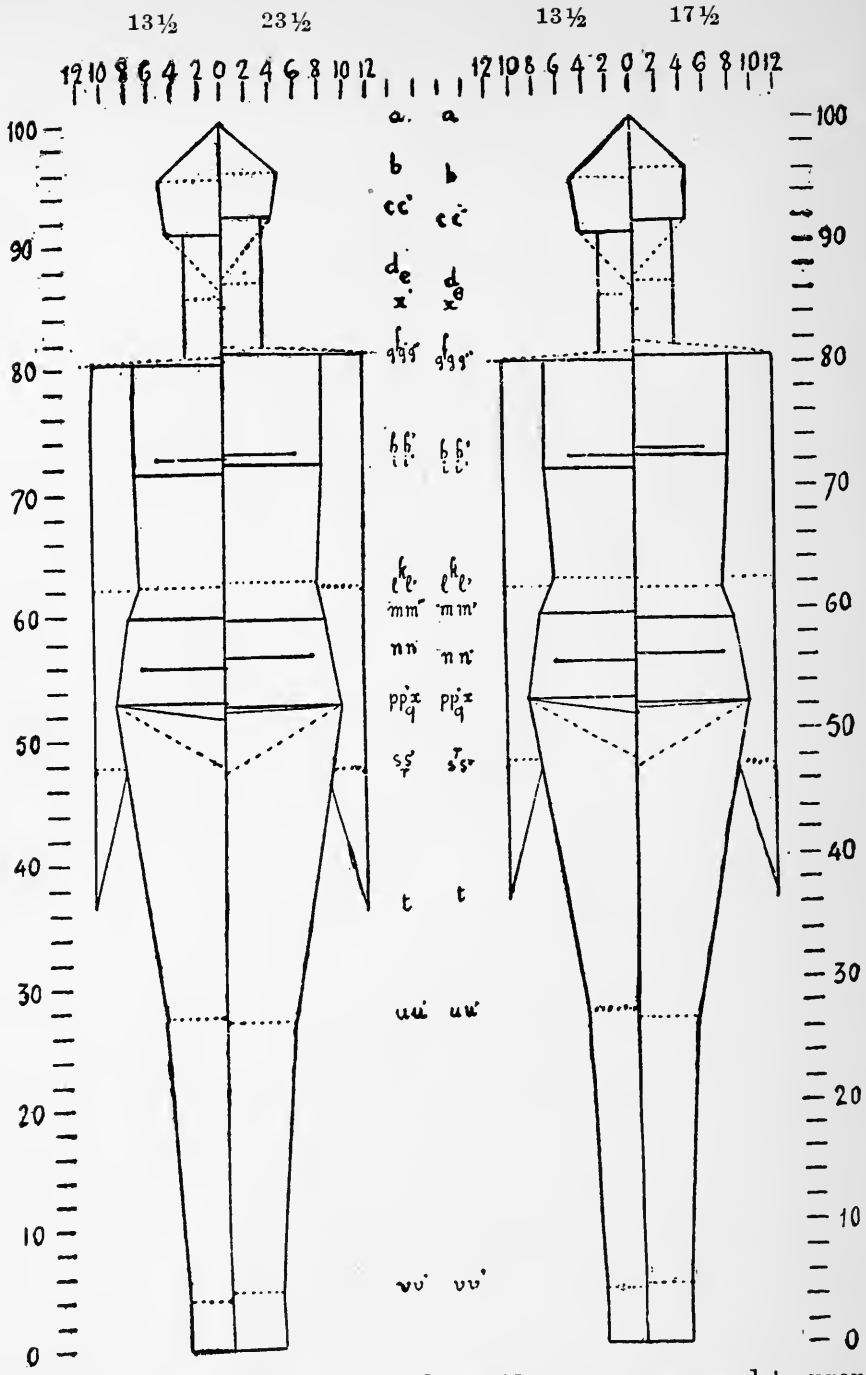
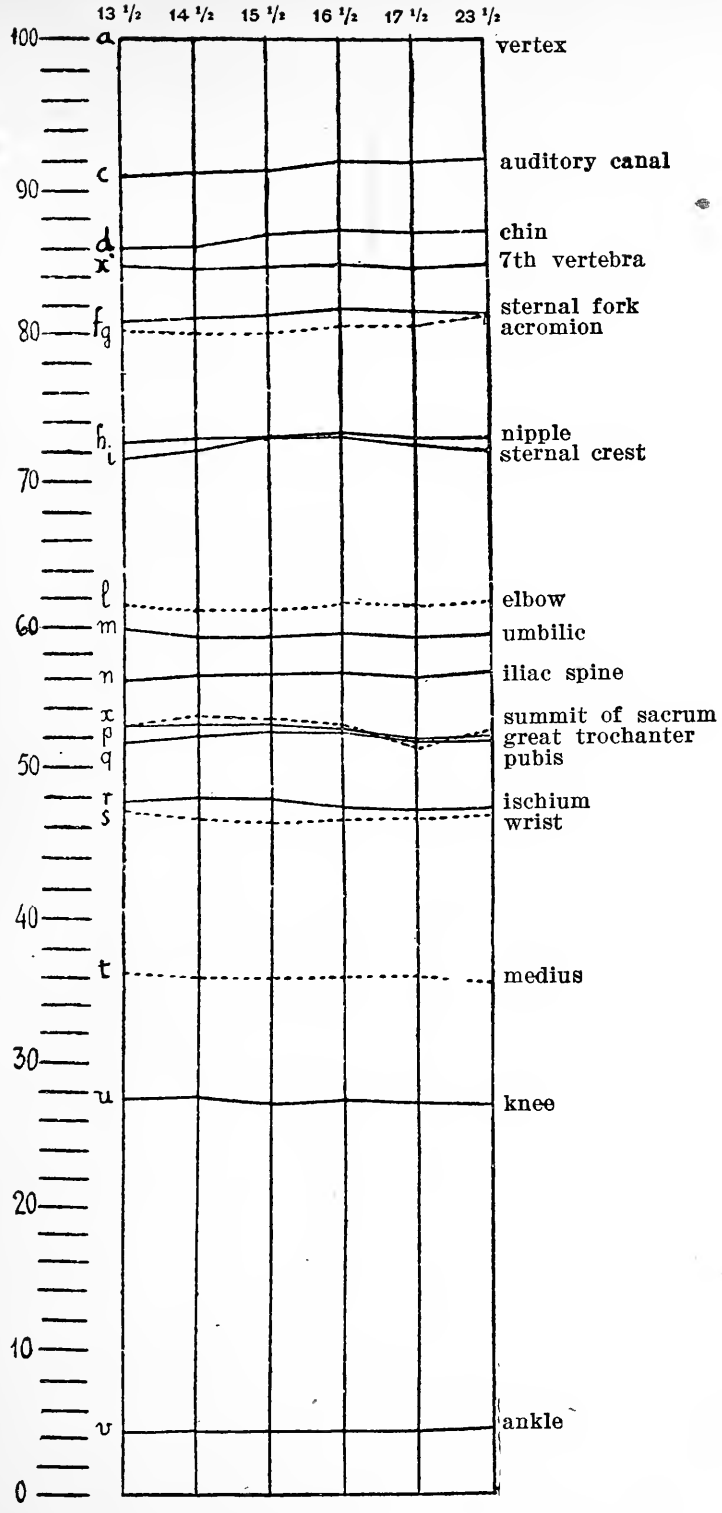


PLATE VI.—Proportions of the body at 13½ years compared to proportions at 17½ and 23½ years.

(Plate reproduced by courtesy of the Anthropological Society of Paris.)

PLATE VII.—Curves of proportional variations of guiding-marks between 13½ and 17½ years.

(Plate reproduced by courtesy of the Anthropological Society of Paris.)



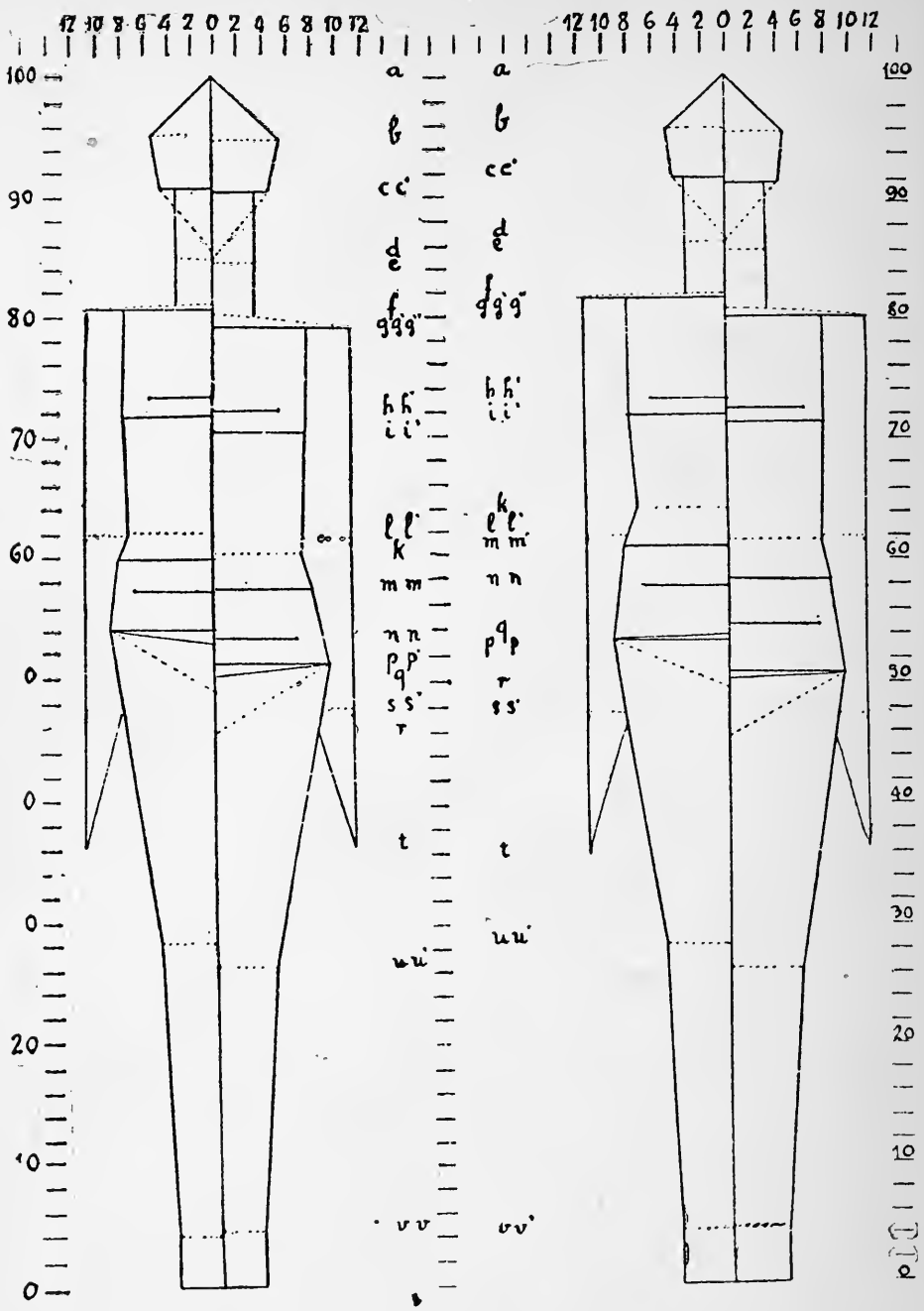


PLATE VIII.—Different proportions of the body in individuals of the same age.

(Plate reproduced by courtesy of the Anthropological Society of Paris.)

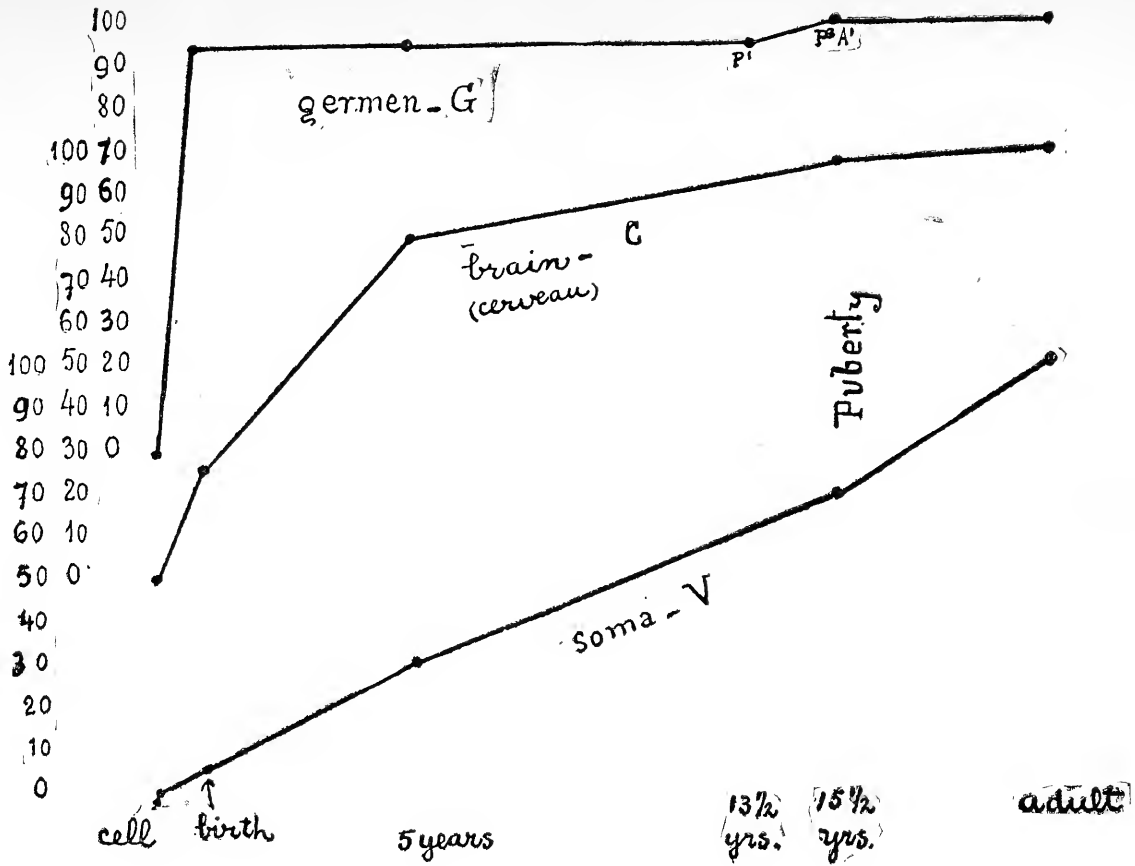


PLATE IX.—Comparative schematic growth of G, of C, and of V. (Grand alternations.)

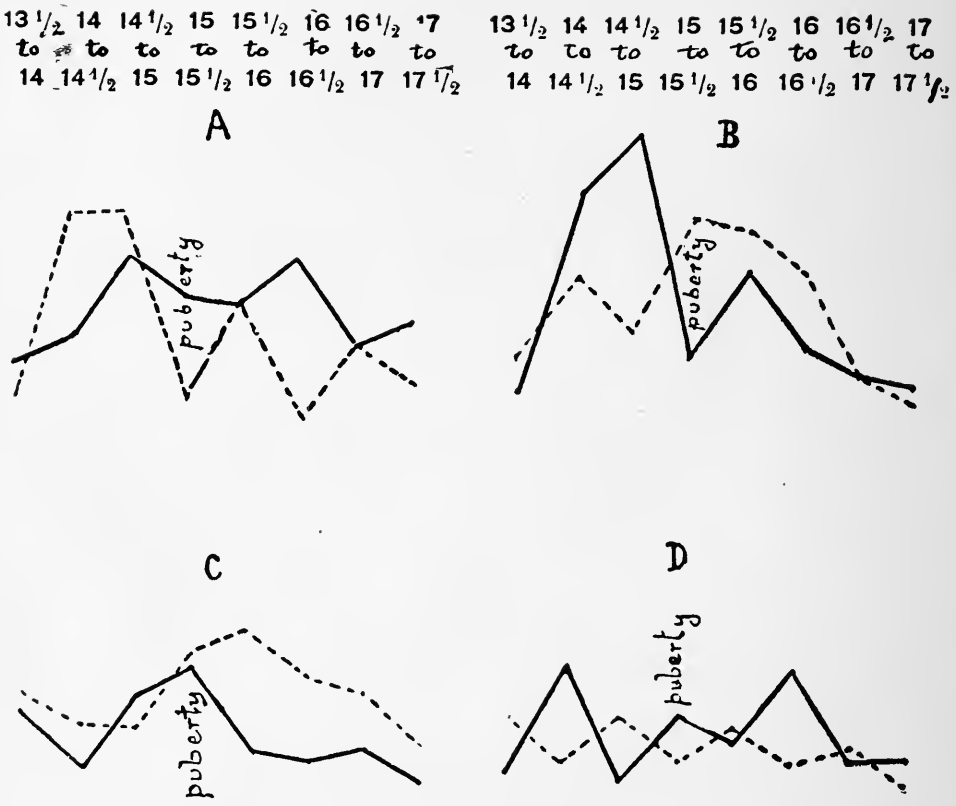


PLATE X.—Semestral alternations of growth between 13½ and 17½ years.

A. Bust ———— Inferior limbs .....
B. Height ———— Weight .....
C. Thigh,- elongation ———— Increase of muscle ..... (maximum circumference)
D. Leg, elongation ———— Increase of bone ..... (minimum circumference)

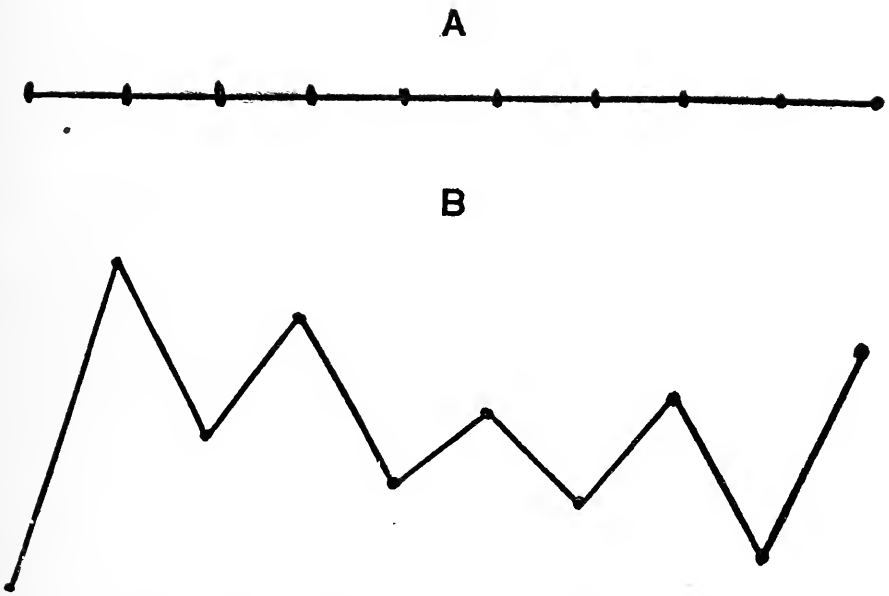


PLATE XI.—Height erect A, and height seated B.

A. Represents the line of the vertex of ten boys of 17 years erect.
B. That of the same ten boys seated.

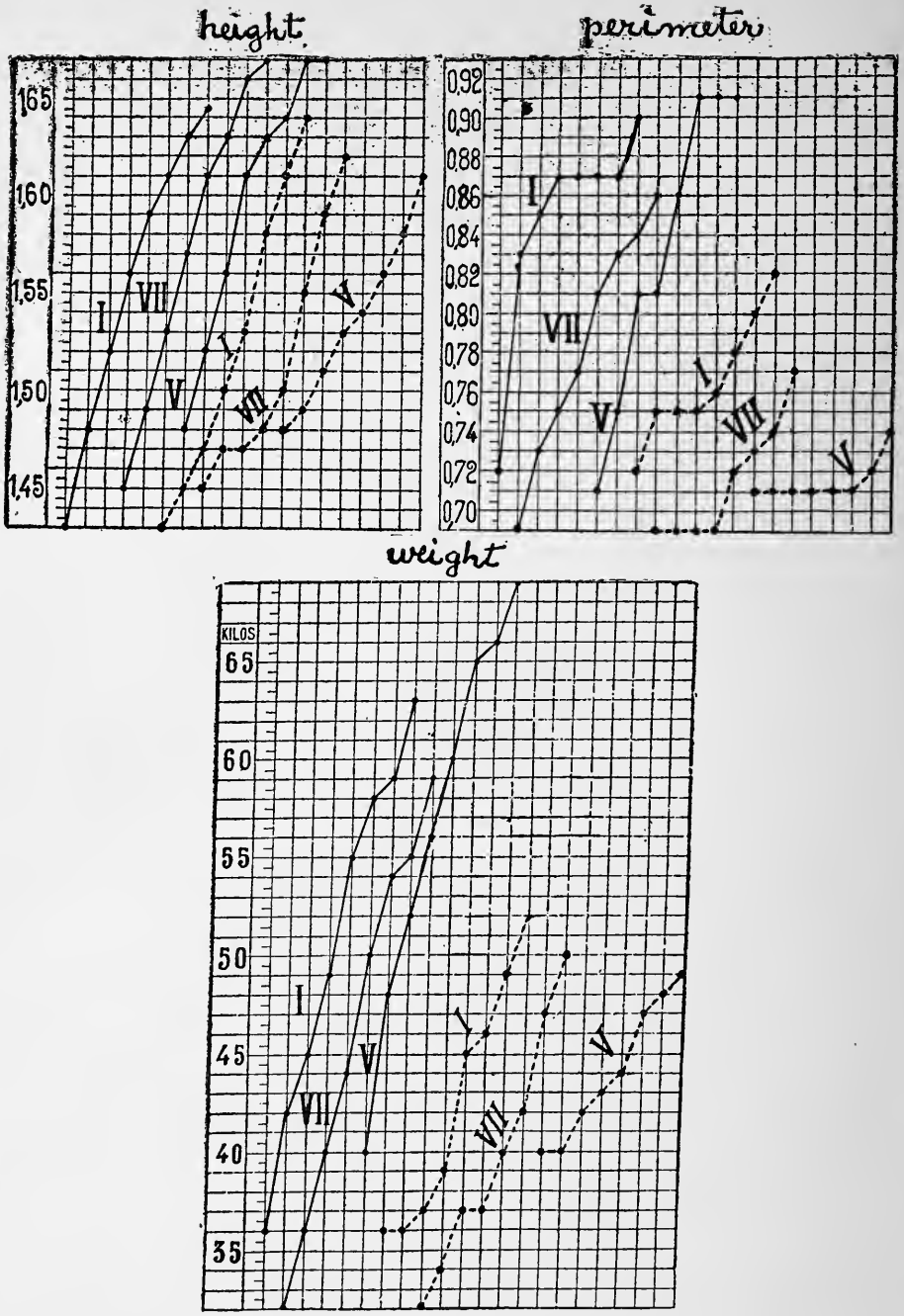
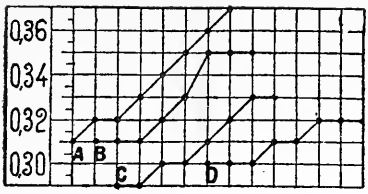
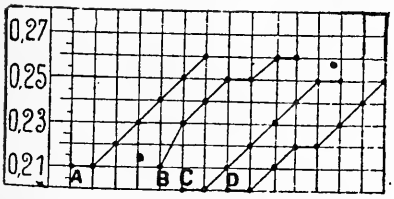


PLATE XII.—Check of the effect of gymnastics (height, perimeter, weight). The solid lines represent the gymnasts, and the dotted lines the non-gymnasts.

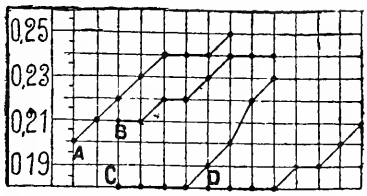
(Plate reproduced by courtesy of the Anthropological Society of Paris.)



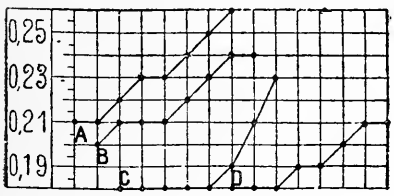
Biacromial diameter



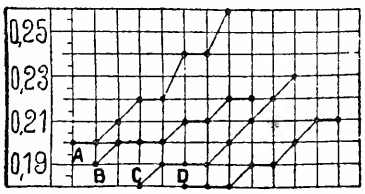
Transv. dia. of pelvis



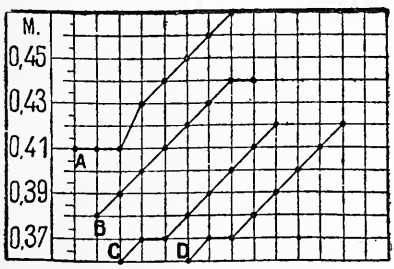
Transv. dia. of thorax



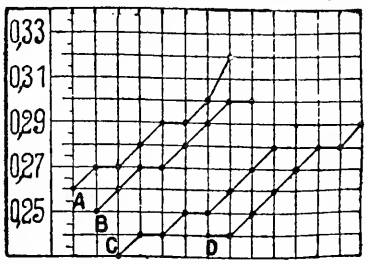
Arm: max. circumference



Forearm: max. circumference



Thigh: max. circumference

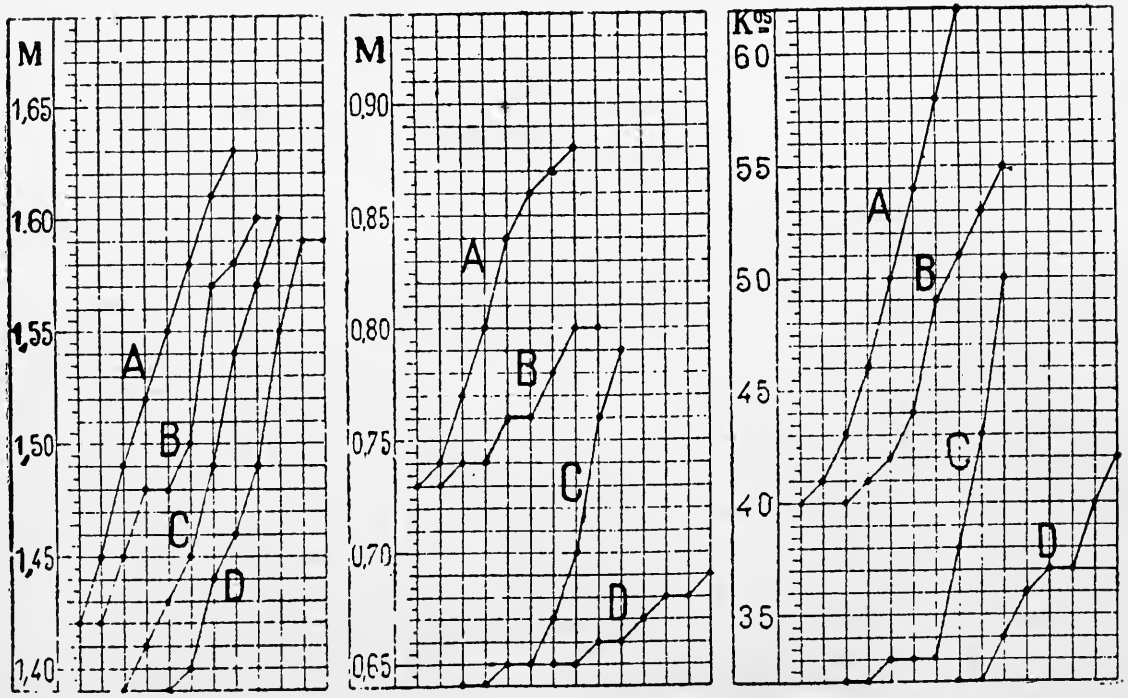


Calf: max. circumference

A. 50 gymnasts.
B. 50 non-gymnasts.
C. Sickly gymnasts
D. Sickly non-gymnasts

PLATE XIII.—Check of the effects of gymnastics (diameter and girth).

(Plate reproduced by courtesy of the Anthropological Society of Paris.)



height *girth* *weight*

A. 50 gymnasts. B. Non-gymnasts.
C. Sickly gymnasts D. Sickly non-gymnasts

PLATE XIV.—Check of effects of gymnastics (height, girth, weight).

(Plate reproduced by courtesy of the Anthropological Society of Paris.)

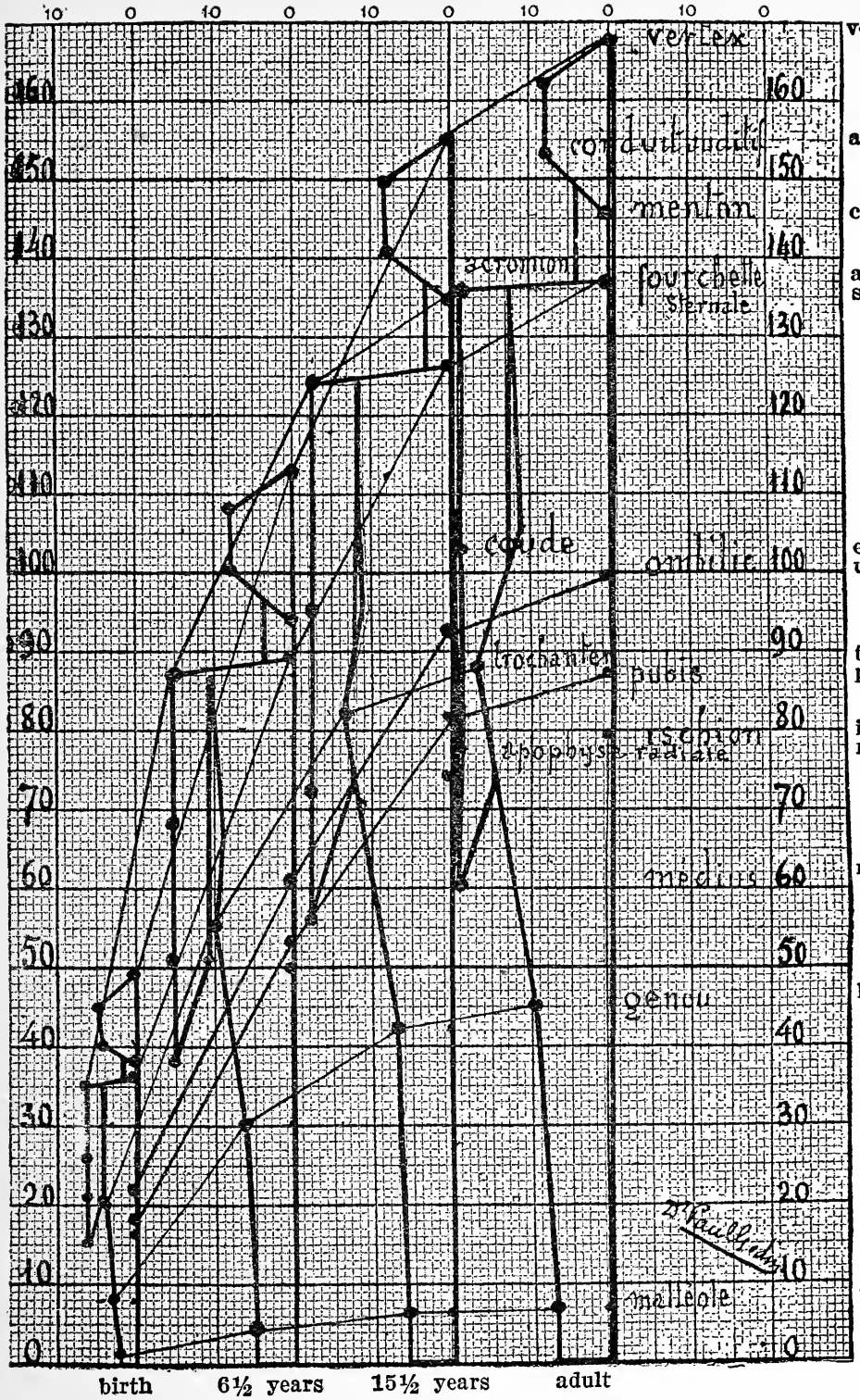


PLATE XVI.—Guiding-marks. Geometric semi-silhouettes and curves of growth.

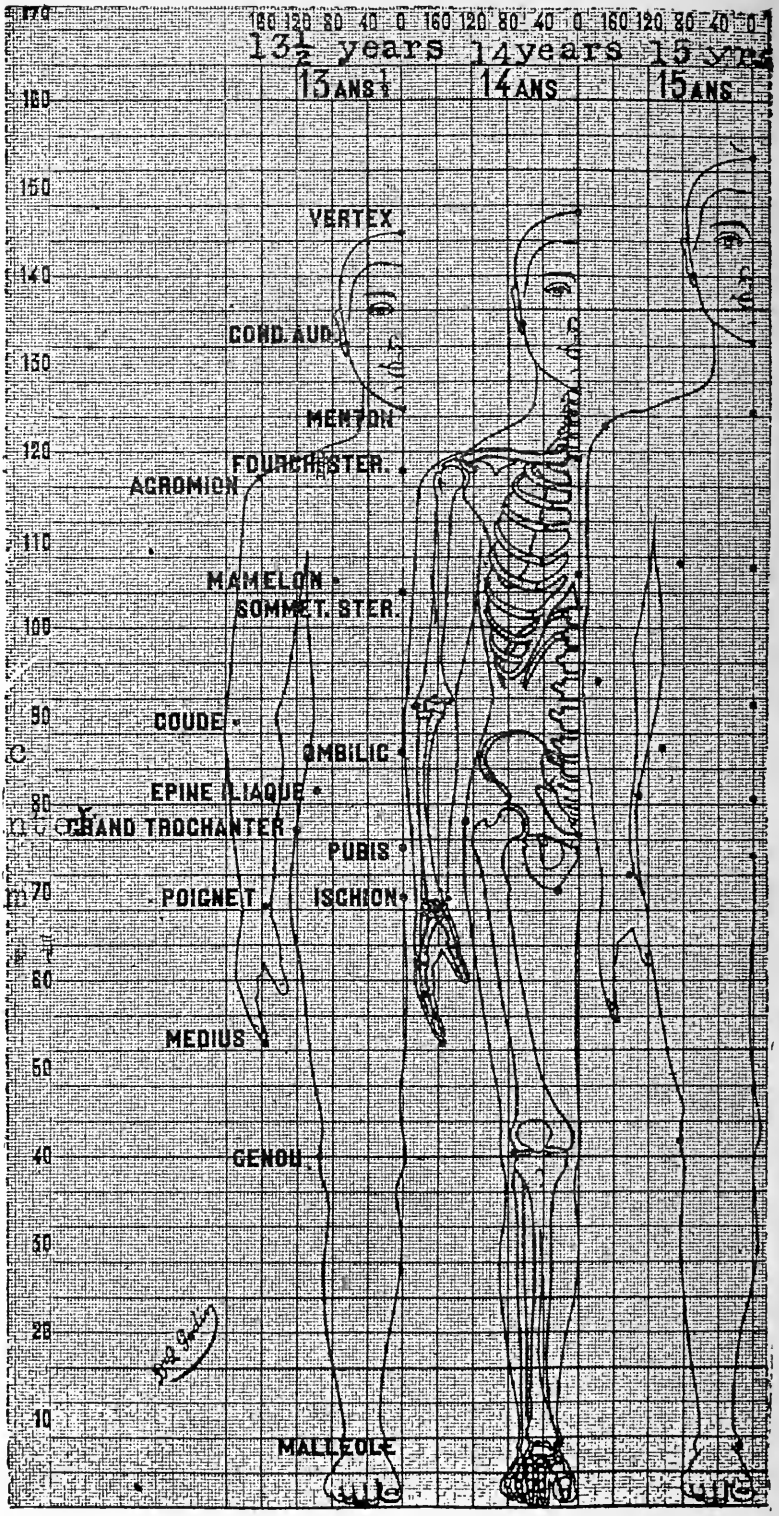
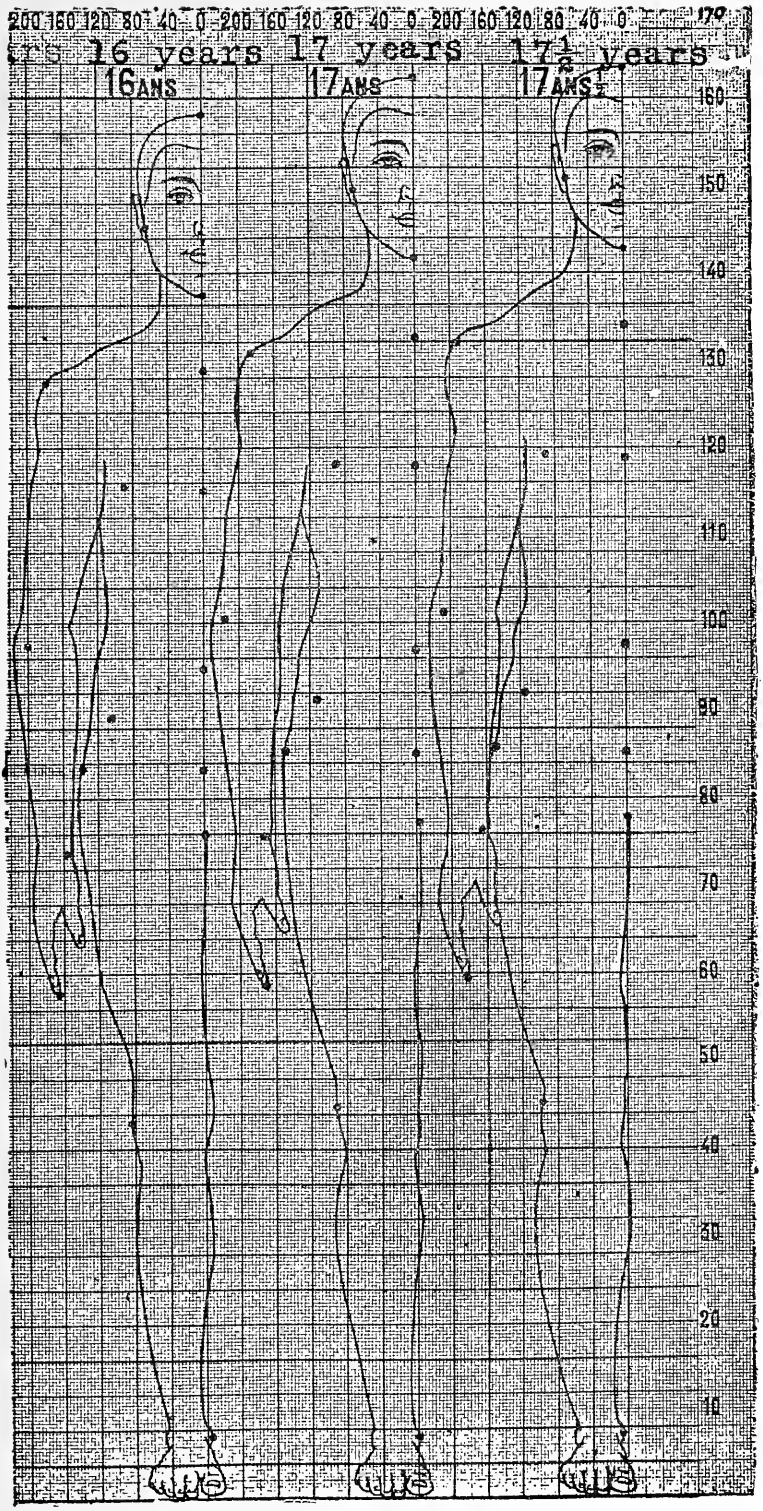
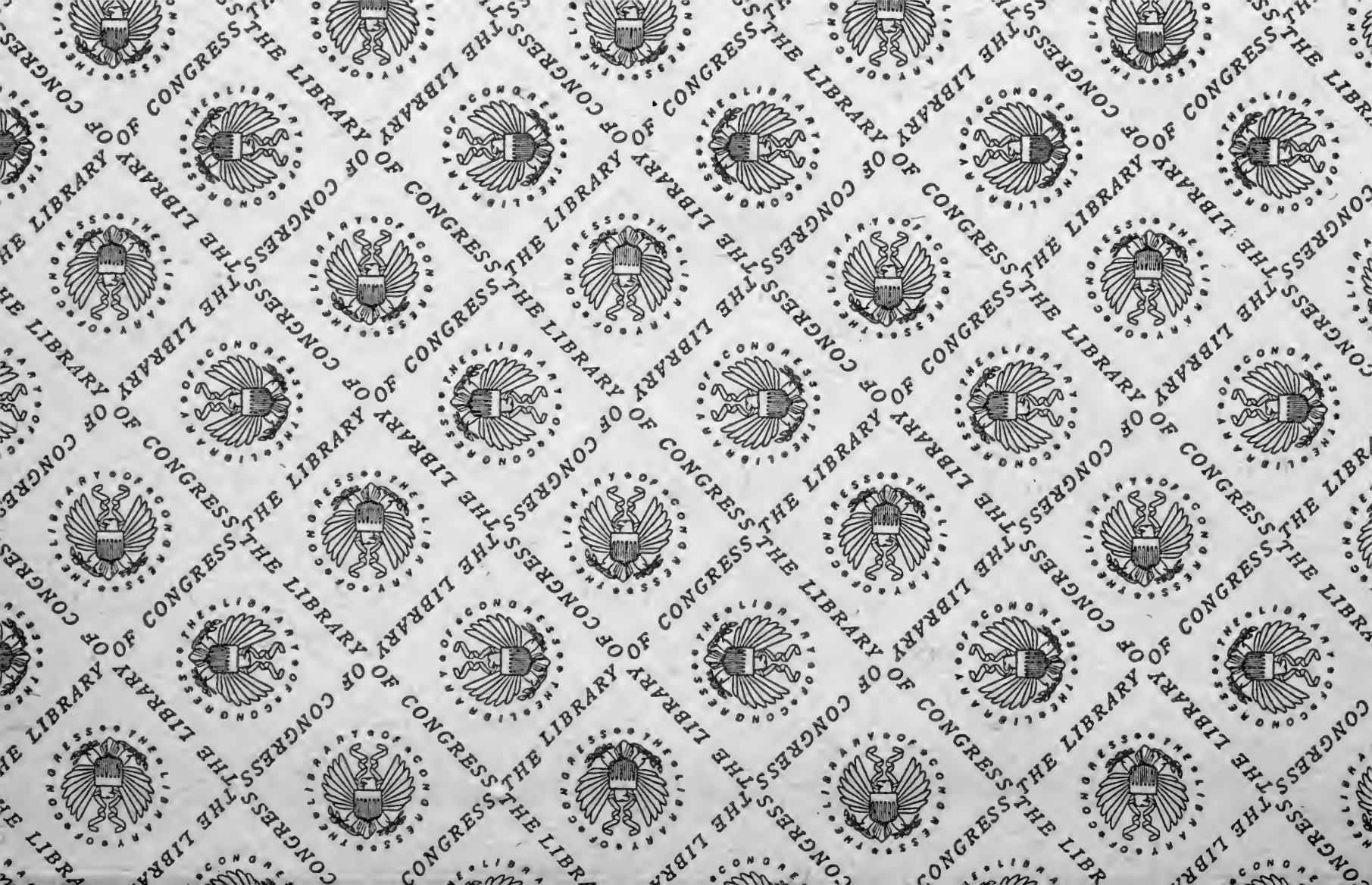


PLATE XV.—Guiding-marks on the skeleton



and on the silhouette at different ages.

INDEX


THE LIBRARY OF CONGRESS